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JOURNAL

VOLUME 10, NUMBER 2 • FEBRUARY, 1954

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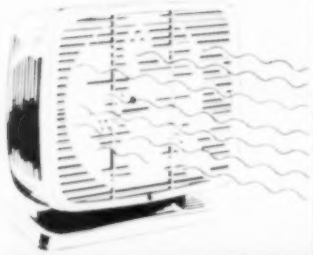
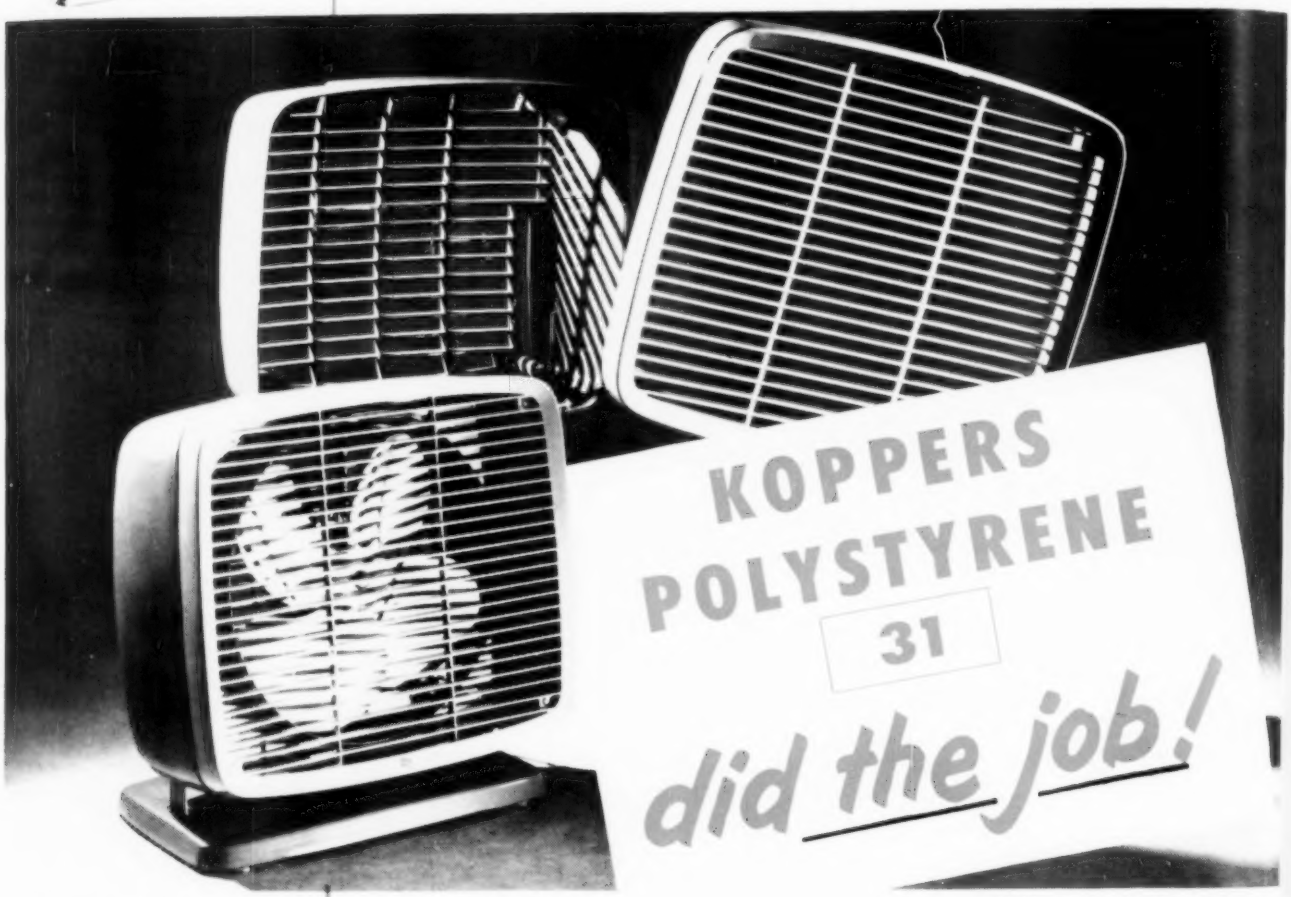
FEB 17 1954
EAST ENGINEERING

Hard PVC pipes over a foot in diameter extruded in Turin, Italy by Lavorazione Materie Plastiche. Story of European extrusion industry by E. Davey-Turner begins on page 18.

PUBLISHED BY THE SOCIETY OF PLASTICS ENGINEERS, INC.



They needed a plastic that was light weight, attractively finished and dimensionally stable.



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The Society of Plastics Engineers Journal is not responsible for the views expressed by individual contributors. Copy for each issue should be received at The Security Bank Bldg., Athens, Ohio before the first of the preceding month.

Across the Editor's Desk

• Your editor has just finished checking over the papers written for the tenth SPE Technical Conference, getting them ready for the printer. Very pleased to find that the average quality is the best ever, and that there are several papers which will be real landmarks. Three of the Conference papers appear in this issue; I won't comment on them here except to say that on the fourth reading (Your ed. has to read everything at least that many times, what with one thing and another)—on the fourth reading, they were still interesting!

• We have just finished reading a fascinating article by an author outside the plastics business which deals with the making of molds for toys. It appeared in the October 1953 issue of Playthings Magazine, and features an interview with Islyn Thomas of Newark Mold and Die. Best way to get a copy of the article is to write to Is Thomas at Newark Die, 20 Scott St., Newark 2, N. J.

• There's a brief note on the new vinyl Film Standards on page ten of this issue, which we hope you won't overlook. The establishment of such standards is a great boost to the industry and a strong bid for the public confidence.

• Incidentally, we hope you've noticed that the SPE Journal has been a bigger magazine this last year, increasingly strong in editorial content. And frankly we can see no direction but up; plans for the coming year are to provide the best possible fare, and every service we can render. Give large credit to our advertisers, old and new—they are good people to do business with.

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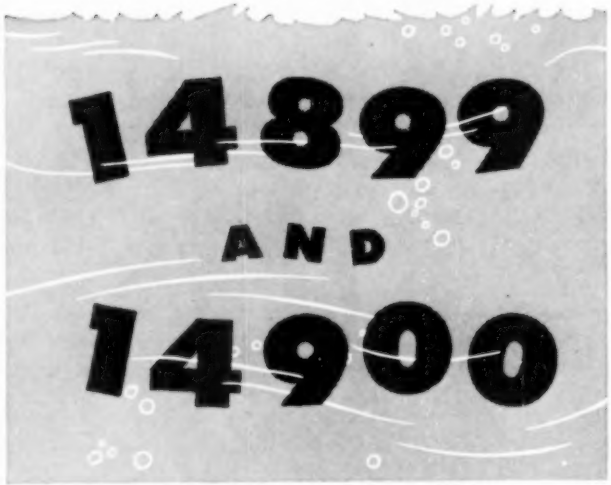

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Your National Office

On December 31st—the half way mark in our fiscal year—every segment of your Society's operation was in a strong and healthy condition.

Assets of the National Organization alone totaled **$30,000** in round numbers. **Cash on deposit in banks exceeded $26,000** of which approximately $10,000 is reserved for use outside the routine expenditures of your National Organization.

Over $7500 has been returned to the geographical sections of the Society in this six-month period. With the continued dues payments of members and the fees of new members acquired through our membership campaign the sections should receive an additional $5,000 in the coming six months.

Income for the National Organization for the twelve month period ending June 30th, 1954, should exceed $50,000! These funds, under your direction as voiced by your National Councilmen, will be used to improve and expand the activities and service of your Society to you the member, primarily but indirectly to individuals throughout the entire plastics industry.

The Journal is also on a sound financial operating basis with revenue equal to cost. Nevertheless, indications are that part of the Society's overall income will be used to complete development of our program of the SPE JOURNAL. Additional outside professional talent will probably be employed. Consideration is being given to putting the JOURNAL on a twelve-month schedule rather than the present ten issue one. A ratio of advertisements to editorial material should be definitely established to insure a well balanced magazine. Advertisements are now unofficially limited to 25% of editorial content.

A small portion of the income is budgeted to finance the relocation of your National Office. I have recently recommended to your National Council that the new location be New York City. Contingent on acceptance by the Council, the Editorial Office of the JOURNAL will remain here in Ohio as a branch office with the New York office as headquarters for the Society.

These are some of the factors that might serve as a background against which you read the December 31st financial report of the Society. The detailed statements are available in the minutes of the National Council Meeting in Toronto on January 26th. They should make interesting reading. And I think you will agree that the condition of the Society that they evidence augurs well for our continued success.

P. L. Underwood
Executive Secretary

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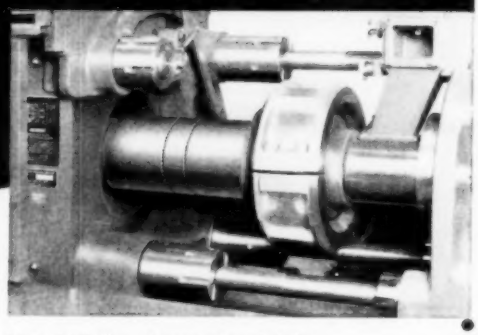

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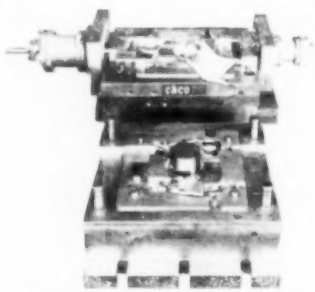

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Book Reviews—

ORGANIC PROTECTIVE COATINGS, by William Von Fischer and Edward G. Bobalek, Reinhold Publishing Corp., 330 W. 42nd St., New York; 387 pages, 7.50

This book is the result of a series of lectures at Case Institute of Technology dealing with paint as an engineering material. Chapter 9 is Vinyl Resins for Organic Protective Coatings, and deals with formulation, stabilizers, and recent developments. Chapter 10 is titled Aminoplast Resins for Organic Coatings; Chapter 13, Fundamentals of Formulating Emulsion and Latex Paints; Chapter 14, Metal Protection with Synthetic Resin Coatings; Chapter 15, Organic Coatings for Electrical Insulation; Chapter 16, Silicone Resins in Heat Resistant Paints.

Thus about a third of the book deals with plastics materials as used in paints, and should therefore be of considerable interest to those in this and allied fields.

The book as a whole seems authoritative and well done; but as is always the case when there is a different author for each chapter, the quality of writing is somewhat uneven. As an old proof-reader, your reviewer spots the apparently inevitable few misprints, such as "trail" for "trial" on page 38; and a rare sentence of a type which crops up more or less normally, such as that on page 21. "There is no variable more difficult to control—than the weather." These are picayune items, and do not detract from the genuine usefulness of the book to those in the business of protective coatings.

PLASTICS PROGRESS 1953: Papers and discussion at the British Plastics Convention 1953. Published on October 23rd, 1953, for "British Plastics" by Iliffe & Sons Limited. Price 50s.Od. (postage ls. 4d.) Size R8vo 9¾" x 6". 438 pages. Cloth bound.

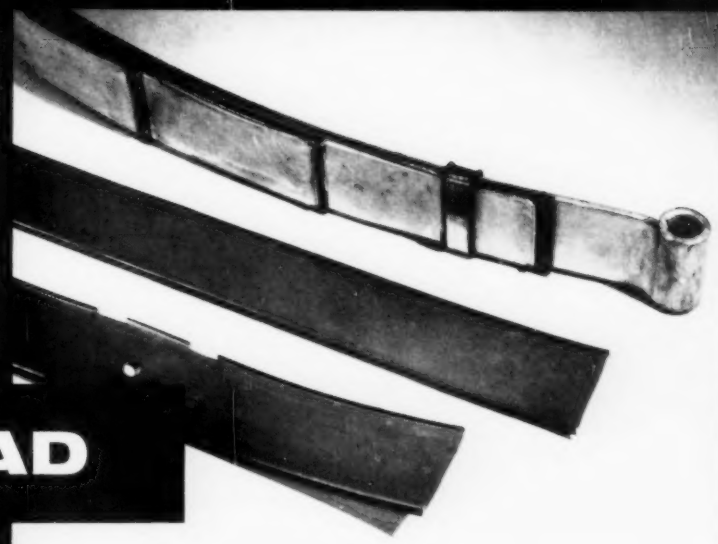
This book is an up-to-date report on several important branches of plastics technology, based on the papers given and the discussions following them in the British Plastics Convention held in June 1953. Contents cover plastics materials, methods and uses. There is special emphasis on glass and asbestos reinforced plastics, and six papers are devoted to this subject, including the first publication of collected data on the properties of asbestos reinforced plastics. This paper was described in discussion as "the reference work on asbestos phenolic materials." Another rapidly developing material is unplasticized polyvinyl chloride in various forms, and it is indicative of current interest that two chapters (one on composition and another on properties, fabrication and uses) are given to this subject. Other material developments are reported in chapters on melamine resins, polyamides and polyesters, and silicone resins. The durability and performance of plastics materials in service is described by experts from the Post Office — a large consumer of plastics — and by an authority on wood adhesives.

Molding problems are described under two heads: one author deals with the economics of large moldings, while another expert describes the factors involved in high quality injection molding. This latter paper, which forms 40 pages of the book, is of great importance to molders and engineers, and contains much information hitherto unpublished, and an account of original investigations.

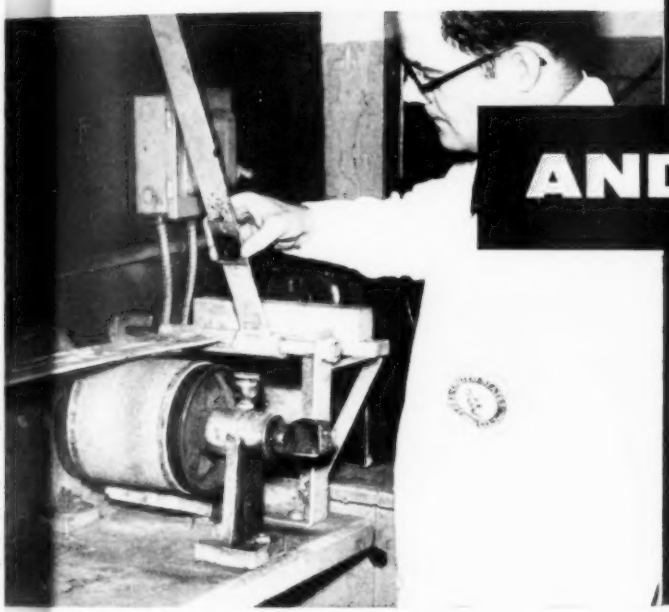
Developing fields for plastics are described in four chapters on new uses in industry. These selected fields are cables, vacuum coating, conveyor belting and for

(please turn to page 38)

tested



ON THE ROAD



AND IN THE LAB

Here's double proof of BAKELITE Polyethylene's

wear resistance

On the Road—BAKELITE Polyethylene proves its outstanding wear resistance when molded into automobile leaf spring liners. These "dry lubricants" fit tightly between the leaves, preventing squeaks caused by metal-to-metal contact. Their waxy surface is unaffected by hot or cold weather. Their molded flanges hold the leaves in line and seal out grit that can cause spring breakdown. These liners won't absorb moisture, and are unaffected by salt and other snow-melting chemicals.

In the Lab—the wear resistance of BAKELITE Polyethylene is shown by tests described in a report by the U. S. Testing Co., dated Sept. 24, 1953. In comparison with a well-known rubber-type compound, BAKELITE Polyethylene was tested by rubbing it against various surfaces with a rotary motion, a reciprocating motion, and a combination of both. The abrading agents were "Aloxite" 320 metal cloth, cold-rolled steel, and maple wood.

Conclusion stated that BAKELITE Polyethylene possessed "superior abrasion resistance." In one test, involving rotary motion, and employing "Aloxite" 320 as the abrading agent, BAKELITE Polyethylene lost 40 to 45 per cent of its thickness in 2000 revolutions, while the rubber-type compound lost 75 to 80 per cent in 280 revolutions.

Such evidence of the toughness and wear resistance inherent in BAKELITE Polyethylene indicates increased use of this material for molding and extrusion applications where service conditions will be severe. Wire covering is an example. Complete details on the abrasion resistance tests are given in KABELITEMS No. 67. For your free copy, write Dept. TJ-43.

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Thermal Degradation of Polymers During Molding

A Note on an Autocatalytic Example

H. L. Frisch and V. T. Stannett

In the article "Thermal Degradation of Polymers During Molding" by H. L. Frisch and V. T. Stannett which appeared in last month's issue of the SPE Journal, means of calculating the amount of degraded polymer used in a molding operation, and the kinetics of the degradation were calculated for several cases. Since the breakdown of some polymers is catalyzed by their own break-down products, we asked the authors if they would be kind enough to calculate out this case also. They obliged, with the results given here.

AUTOCATALYTIC REACTION

Consider the case where the polymer may be degraded according to the following scheme, where **a** is the initial concentration of polymer, **b** is the constant concentration of degradation reagent (such as oxygen, HCl, or the like).

Polymer plus **reagent** react to give a **product-catalyst** (specific reaction rate constant K_1). This product-catalyst then yields final degradation products. The concentration of polymer at any time is (a-x), the concentration of the product-catalyst is (x). We then write:

(a-x) + (b) yields (x)

and then; since the polymer reacts with the product-catalyst to give final degradation products (specific reaction rate constant K_2), we write:

(a-x) + (x) yields final degradation products.

Then: $dx/dt = K_1b(a-x) + K_2(a-x)x$

which on integration yields:

$$D(t) = D(it) = x/a = \frac{1-e^{-Kt}}{1+Be^{-Kt}} = \frac{1-e^{-Kti}}{1+Be^{-Kti}}$$

with $K = K_1b + K_2a$ and $B = aK_2/bK_1$

Hence,

$$Z_n = \sum_{i=0}^{n} \left[\frac{1-e^{-Kti}}{1+Be^{-Kti}}\right] u(i,n)$$

which reduces, as n approaches infinity, to

$$Z_{n\to\infty} = 1-(1+B)\left[\frac{1-a}{1-e^{-Kt_a}}\right] + B\left[\frac{1-a}{1-e^{-2Kt_a}}\right]$$

neglecting terms of order B^2.

WHY THESE TWO LEADERS GOT TOGETHER

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WATSON-STILLMAN
INDUSTRY'S LEADER
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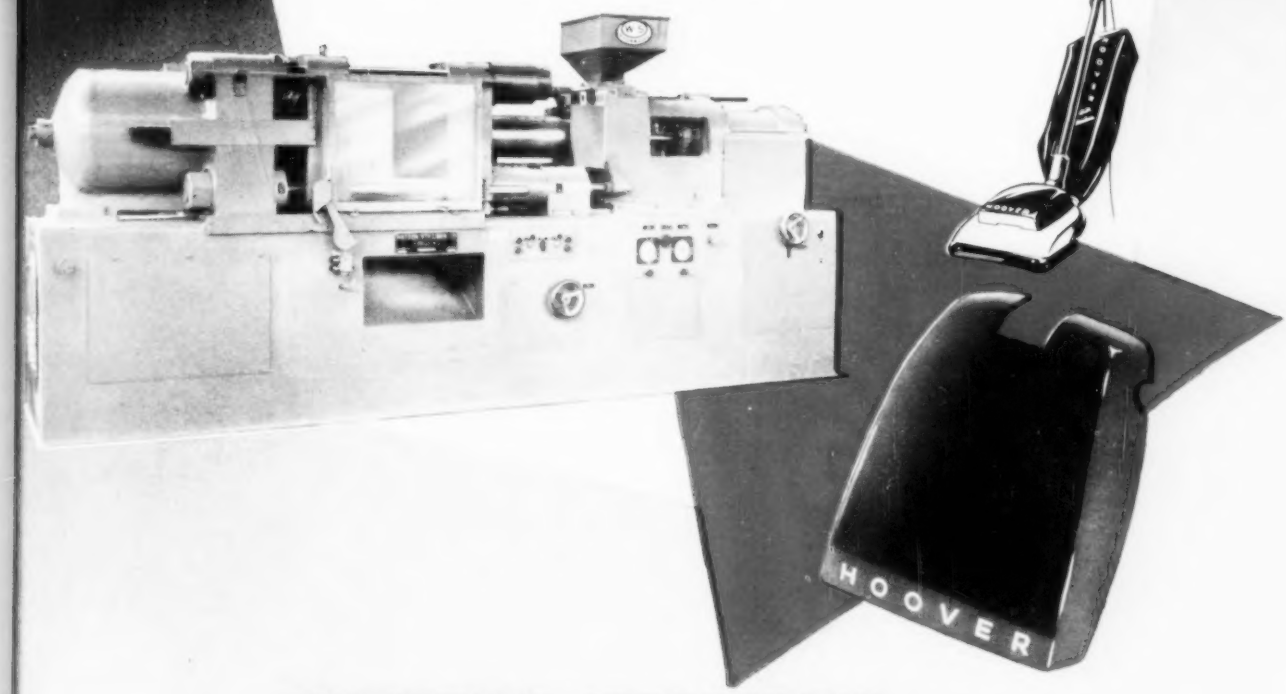
At one time or another since 1949 almost every plastic part of a Hoover vacuum cleaner has been molded on Watson-Stillman equipment.

- Hoover could not afford to experiment with plastic molding equipment. They had to be sure of performance—sure of production speed—sure of dependability—sure that the machines required very little maintenance.
- A phenomenal production growth from six Hoover Vacuum Cleaners a day in 1907 to a position where one-third of all vacuums in use today are Hoovers, necessitated only accepted, preferred equipment that was standard for plastic molding.
- It was natural, therefore that W-S Injection Molding and W-S Compression Molding machines were installed—a total of 17 machines.
- Consult W-S first about their "Completeline" of Injection, Compression and Transfer Molding machinery. There's a model for every production need.

Send for our latest catalogs—or contact our engineers about your problem.



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Correspondents Throughout the World

Industry Notes

Commercial Standard for Vinyl Plastic Film Available

The printed edition of General Purpose Vinyl Plastic Film, Commercial Standard CS192-53, is available for sale by the Superintendent of Documents, according to an announcement by the Commodity Standards Division of the U. S. Department of Commerce.

The standard became effective for new production on May 22, 1953, and is referenced in the Flammability Fabrics Act, Public Law No. 88 of the 83rd Congress, effective June 30, 1954. The specification covers methods of test and requirements of general purpose plain or embossed vinyl plastic film to insure satisfactory products for consumer use. The requirements and methods of test specify thickness tolerances, yield per roll, width tolerances, shrinkage at elevated temperatures, contamination, appearance, cracking, tensile properties, tear resistance, volatility of plasticizer, water extraction, low temperature impact flammability. Suggested forms for declaring compliance with the standard, and an identifying hallmark are included.

Copies may be purchased from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for ten cents each.

New Mold Release for Polyester, Epoxy, and Other Materials

A new mold release for polyester, epoxy, and other plastics and materials has just been developed by the Chemical Development Corporation of Danvers, Massachusetts. This new product is intended for use primarily on porous or semi-porous molds, including wood, polyester, plaster of Paris, aluminum, and similar materials. It also has several additional uses because of its high heat resistance and other characteristics. It is believed to be the most effective release agent available today for these plastics. It is no longer necessary to pry and hammer large parts, including boat hulls in order to remove them from the mold. If the lubricant has been properly applied, the product can be easily and quickly removed.

CD MOLD RELEASE B-2 is supplied as a paste. It can be easily applied to the mold surface with a cloth or brush and can be rubbed down if desired to a thin coating which is practically invisible.

Nu-Jett Grinder Adds Safety

Added safety has been built into the newest Nu-Jett Pencil Grinder, the 100,000 RPM grinder made by Nu-Jett Products, 1355 Michigan N.E., Grand Rapids, Mich.

The newest model has a safety guard which fully encloses the chuck nut. This guard makes finger burns impossible and gives even more accurate control.

Nu-Jett is the smallest and lightest grinder on the market, 7/8 by $4\frac{1}{2}$ inches and 5 ounces in weight. With its speed of 100,000 RPM it can etch, grind, polish, debur

Bulletin Describes New Stokes Plastics Molding Press

The new Stokes Model 731 semi-automatic compression molding press of 150-ton capacity is described in a new bulletin, No. 516, just issued by the F. J. Stokes Machine Company, Philadelphia, Pa.

The redesigned Stokes toggle press is especially suited for molding parts like resistors, capacitors, and others requiring delicate insert work, parts with thick and thin sections, or parts with pins and projections.

Closing time of the press is reduced and potential mold damage is eliminated by an improved design of three-stage closing. A new regenerative oil circuit almost doubles the initial closing and opening speed of the toggle.

Copies of Bulletin No. 516 may be obtained free on request by writing the F. J. Stokes Machine Company, Philadelphia 20, Pa.

Section Membership Competition

Goal: Membership of 5000 by October 1, 1954

SECTION	MEMBERSHIP Oct. 1, 1953	NEW APPLICANTS Oct.	Nov.	Dec.	% Increase
Baltimore-Washington	49	1	0*	0*	2
Buffalo	65	3	1	1	8
Central Ohio	33	0*	1	0*	3
Chicago	315	7	10	4	7
Cleveland-Akron	148	10	4	3	11
Connecticut	86	1	5	1	8
Detroit	173	6	0	7	8
Eastern New England	132	1	1	3	4
Golden Gate	32	3	2	0	16
Miami Valley	102	1	1	0	2
Newark	321	9	17	5	10
New York	248	1	17	4	9
Northern Indiana	21	1	0*	0*	5
Northwest Pennsylvania	75	4	2	2	11
Ontario	43	3	14	6	50
Philadelphia	174	6	0	3	[illegible]
Pittsburgh	6	3	4	1	[illegible]
Quebec	25	5	2	9	[illegible]
Rhode Island & S. E. Mass.	68	2	2	0	[illegible]
Rochester	65	4	3	3	[illegible]
St. Louis	71	0	4	9	[illegible]
Southeastern Ohio	36	0*	4	0*	[illegible]
Southern California	96	6	7	2	[illegible]
South Texas	32	5	0	1	[illegible]
Toledo	59	0*	0*	0*	[illegible]
Upper Midwest	54	4	1	0	[illegible]
Western New England	135	7	8	0	[illegible]
Non-Section	37	0	3	3	[illegible]
TOTALS	2704	93	113	73	[illegible]

*Membership Chairman please note.

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Arcing Tests on Plastics

Thomas J. Martin and Raymond L. Hauter

The Boeing Airplane Co., Seattle, Washington

INCREASING CONCENTRATION OF electric power at higher voltages in the airplanes of today has made essential a review of the usage of insulating materials which, by their nature or by their application, may constitute a fire hazard under abnormal conditions of circuit or equipment failure. Boeing's interest in this problem was stimulated by the occurrence of fires which were severe enough to burn large holes in the aluminum supporting structure in the laboratory mockup of an electric system.

These fires were caused by dual failures. Current limiters (high-accuracy fuses) which had been satisfactory for smaller systems exploded in fault tests in circuits containing 60-kva 208 120-volt 400-cps aircraft alternators. This arc would strike the phenolic block supporting the limiters and carbonize the surface of the phenolic, changing it from an insulator to a conductor. The phenolic material gave off gases which burned with the violence of a blow torch. Surrounding structure was destroyed and the circuit was not interrupted until either the power wires fused or the block was completely destroyed.

To make matters worse, blocks frequently survived minor flashovers with no obvious damage, and then broke down hours or days or weeks later.

There were also cases of blocks carbonizing and flashing over because of screw terminal connections becoming loose and generating enough heat to carbonize the block. One of these is shown in figure 1.

Obviously, it became necessary to find materials which were better able to withstand the ravages of power arcs. This is especially important for such applications as limiters, circuit breakers, and contactors. Where breakdown of the material means possible failure to interrupt the circuit two hazards are created:

1. There is danger of losing the main power supply.
2. There is a direct fire hazard.

Because of these fires, Boeing has conducted a series of tests over a period of about three years to determine the ability of various insulating materials to withstand these severe power arcs. Research is continuing, so that we may learn more about the various materials which may be used in areas where they may be subjected to powerful electric arcs.

It is important to note that the methods used in these tests differ from the standard ASTM test method, and it is especially important to note that the results of these tests do not necessarily agree with results obtained by the standard ASTM test method. The Boeing tests cover the effect of the sustained intense heating caused by power arcs which continue for an appreciable time over the surface of the material in question. This is realistic from a standpoint of aircraft applications.

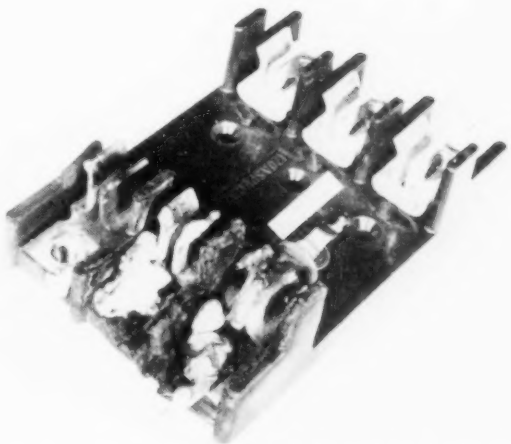

Figure 1. Flashover of Limiter Block Caused by Overheating of Loose Screw Terminal.

The results of these tests were quite spectacular and were recorded on a sound film. (Reference 1)

A caution is appropriate at this point against misinterpretation of the information presented by this paper and the film. They are intended to point to ways of improving the already fine safety record of aircraft. The problem was discovered in the laboratory mockup of a system involving higher voltages and more power than had ever been installed in commercial airplanes. Discovery in the laboratory permitted changes to be made before the system was installed on the airplane.

TEST PROCEDURE

When available, standard 60-ampere limiter blocks made of the desired material were tested. These are similar to and a little smaller than the 120-ampere block shown in figure 1. In the majority of tests, it was necessary to install fuse clips on samples of the material in the manner shown in figure 2. These had the same spacing as the clips on the 60-ampere limiter blocks. In general, three pairs of fuse clips were used; in some cases the shape of the available sample was such that only two could be used.

Copper links were installed in the fuse clips, so that their ends very nearly touched. In the early tests the connection was completed by small drops of solder. The solder melted when a fault current was applied, starting an arc across the surface of the test sample. In later tests it was found that more uniform results could be obtained

T. J. Martin

R. Hauter

Mr. Martin and Mr. Hauter, who presented this paper at the Tenth SPE Conference in Toronto this January, are both Research Engineers in the Acoustics-Electrical Unit of Boeing Airplane Co.

by using a piece of very fine wire soldered to the two pieces of bars to fuse and start the arc. This later modification has proven very satisfactory.

Power for these tests was supplied by 3-phase 400-cps 208/120-volt aircraft alternators. The phase-to-phase voltage (208 volts) was connected to opposite ends of the links. The three (in some cases two) fusible links are connected in parallel, with the center link reversed in polarity, as shown in figure 3. This puts line voltage across adjacent terminals, simulating the actual connection in service. The fault currents were about 800 amperes for single-alternator tests and about 3200 amperes for four-alternator tests.

After the fault was applied the voltage regulator, in attempting to maintain normal output voltage, increased the exciter field current to the maximum obtainable —equivalent to an open-circuit voltage approaching 350 volts. This high field current existed, of course, only when the fault was sustained. When the arc was interrupted, the regulator returned the voltage to normal. In a few tests, which are noted accordingly, the sensing circuit of the regulator was opened just before the fault was applied. This, likewise, caused the field current to increase so that the voltage applied to the fault was 350 volts.

Arc Test Piece

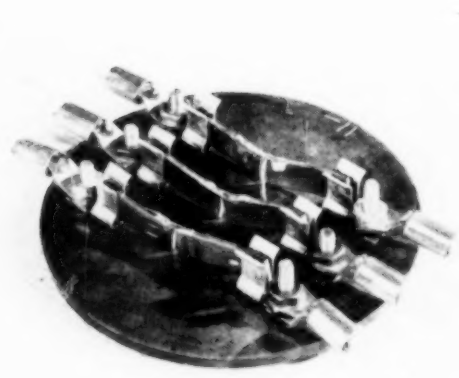

Figure 2. Arcing Test Setup on Disc Sample.

MATERIALS TESTED

These materials will be discussed in ascending order of arc resistance.

Phenolic Materials

Phenol formaldehyde, commonly known as phenolic, was the material whose poor performance caused this investigation to be made. An organic plastic, which comes with a wide variety of fillers, phenolic is probably the most common of the plastic materials.

As is shown in the film (Reference 1) it only took one arc with power from one alternator to cause complete destruction of the material, accompanied by violent flames and much smoke. The arc was interrupted by opening of the control contactors.

Modified Phenolic

One manufacturer succeeded in producing a phenolic material with improved arc resistance. This material had an arc resistance according to the standard ASTM test procedure of 180 seconds. This is comparable with the melamines.

Three tests were made—two on 4-inch discs similar to figure 2 and one on a circuit-breaker case with fuse clips and links mounted on the outside—using one 60-kva alternator. Following the application of the arc, we see the transient response of the generator and regulator. The weak link melted in 0.19 second, by which time the current had reached 825 amperes. As the arc was drawn out, the voltage across the arc increased and the current decreased. The arc was cleared manually by opening the contactor at 1.79 seconds.

The conductivity of the plastic surface was such that the arc restruck immediately when the contactor was reclosed, and continued at all times that the power was applied.

These faults, again, were quite spectacular. Violent flaming accompanied the arcs, continuing with less violence in the periods between the arcs.

Obviously this material, used in limiter blocks or circuit-breaker cases, would give absolutely no protection to the electrical system. Because of these tests, we have concluded that phenol formaldehyde must not be used for electrical insulation in aircraft where there is any possibility of exposure to arcs or where tracking caused by surface leakage is a possibility.

Alkyd Resins—Mineral-Filled

Alkyd resins have been used for a long time for paints and similar applications. Compression molding of alkyds was introduced late in 1948, giving a material that can (and must) be molded very rapidly, can be readily machined, and has desirable electrical properties.

The mineral-filled alkyd resin has an ASTM arc resistance of 180 seconds, surpassing most of the thermosetting plastic materials.

The alkyd resin samples were discs, similar to figure 2. The tests were made with one alternator.

The mineral-filled alkyd resin, with an ASTM arc resistance of 180 seconds, generally withstood one arc at 200 volts. Many of the samples then failed when the voltage was raised to 350 volts. The second arc destroyed the samples surviving the first. A red flame was supplemented occassionally with a column of blue flame about 1 inch in diameter and about 8 inches high. A ½-inch hole was burned through one of the test samples. The burning alkyd gave off a dense brown smoke.

Thus it would appear that the mineral-filled alkyd is better than the phenolics, but still leaves much to be desired.

Alkyd Resins—Glass-Filled

The glass-filled alkyd samples all failed completely on the first arc. Figure 4 shows the complete destruction. The glass-filled alkyd is somewhat inferior to the mineral-filled material in its resistance to power arcs.

Epoxy Resin

Tests were run with one alternator on a material made of laminated glass cloth bonded with an epoxy resin. The test sample is shown in figure 5. This material passed the first test. The resin was burned away leaving the glass fibers exposed, but the arc was interrupted and the insulation remained apparently good. The second arc, however, completely destroyed the material as shown in figure 6. Once started, the arc would not stop until the power was turned off and, when power was reestablished, the arc immediately restruck.

Melamines—Wood-Flour Filled

Two types were tested—melamines with a filler made of wood flour, and melamines with mineral filler.

Three samples of wood-flour-filled melamine, made of halves of circuit-breaker cases, each survived two arcs and failed on the third. However, the voltage was removed as soon as the arc had cleared on these early tests. A fourth test, on a sample limiter block, failed on the first arc.

Melamine—Mineral-Filled

These tests were run with fuse clips mounted on the inside of a relay case molded of mineral-filled melamine formaldehyde. After the fourth test, 460-volt 400-cycle ac was applied. Small pinpoint arcs appeared in the first few seconds. The voltage was applied for 9 hours with no further signs of leakage. This was repeated for $2\frac{1}{2}$ hours after the 6th test. Intermittent pinpoint arcs appeared but there was no breakdown.

(please turn to page 39)

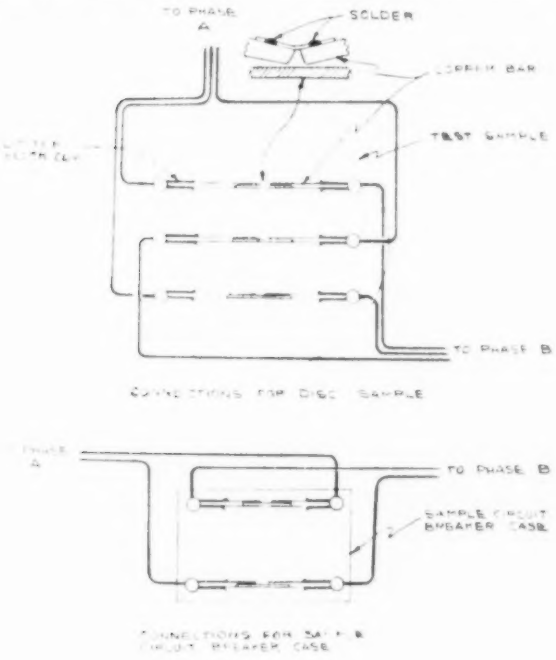

FIGURE 3 CONNECTIONS FOR ARCING TESTS

Arc Test Results

Figure 4. Remains of Glass-Filled Alkyd Sample After One Arc.

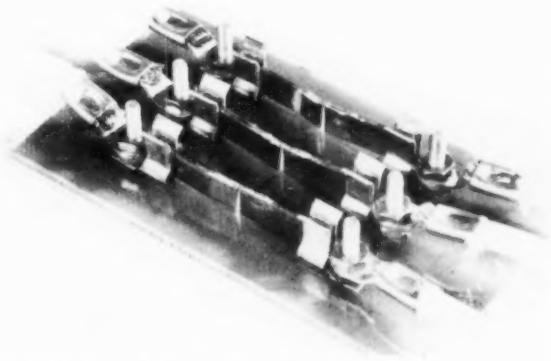

Figure 5. Epoxy Resin Test Sample.

Figure 6. Remains of Epoxy Resin Sample After Two Arcs.

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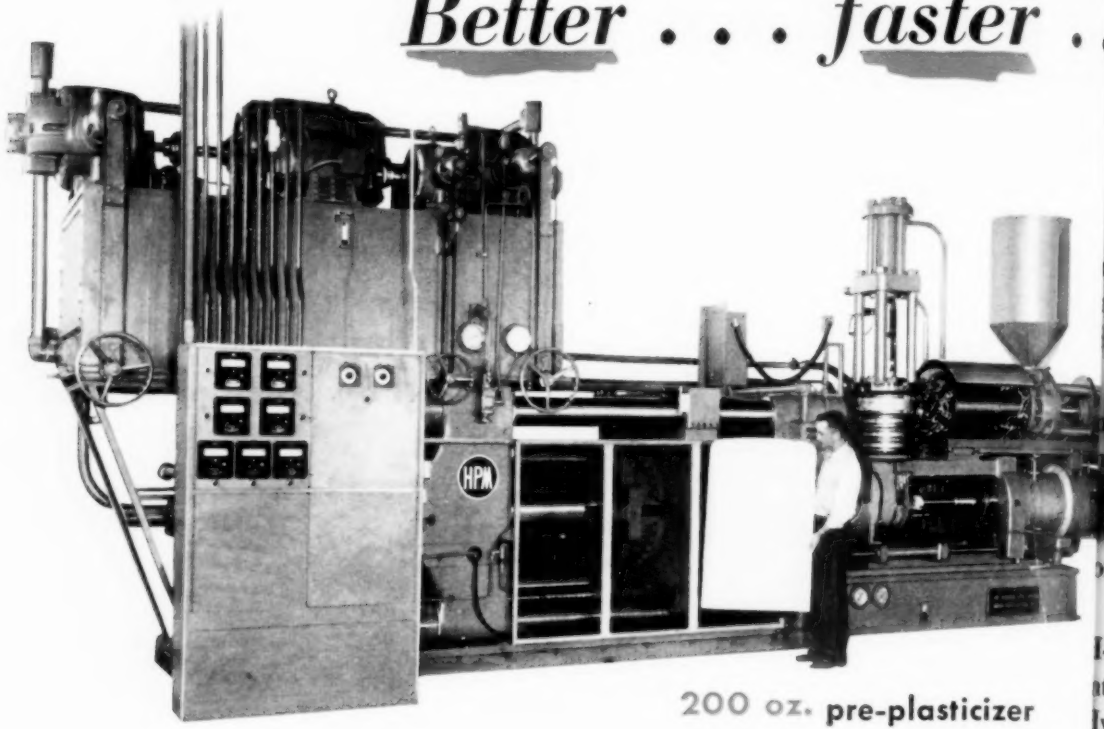

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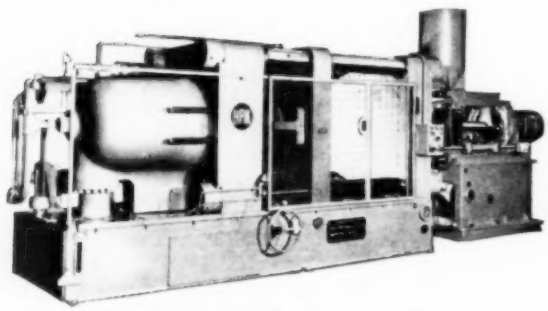

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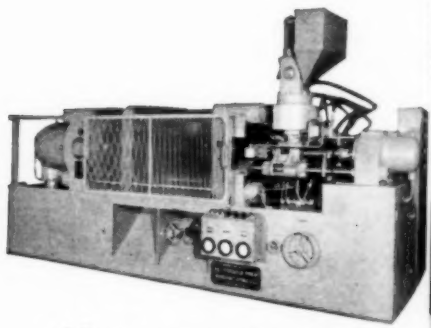

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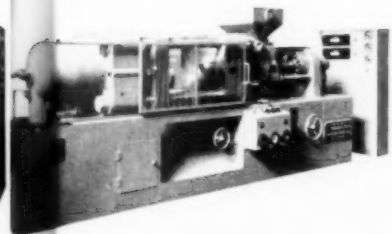
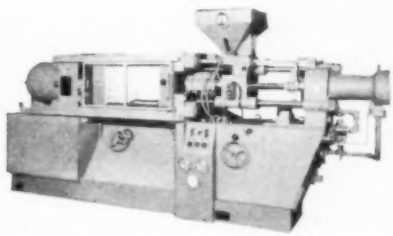


16 oz. standard machine



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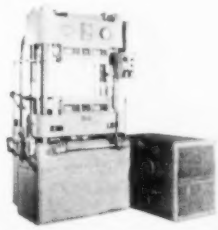

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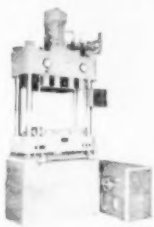

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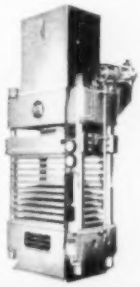

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Extrusion Practice

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The author has confined his paper to the engineering aspects of extrusion, and particularly to the development of the industry in Europe. Viewing generally the industry in that continent the present position is very encouraging, and from recent visits to a considerable number of extrusion plants in many countries an amazingly wide variety of products was noted to be in production.

DEALING FIRST WITH the production of extrusion machines, there has been a marked increase in the number of manufacturers, particularly in Germany, and, to a lesser extent, in France, over the past few years, and it should be noted that a considerable proportion of the new extrusion machines now in manufacture are of the multiple screw variety, which fact would indicate that this type of machine is becoming more widely used and can therefore be assumed to have assisted in the solution of some of the difficulties which accompany the process of extrusion.

It will be generally well-known to all those who have actually had the opportunity of operating an extrusion machine that extrusion can be a most difficult and complicated process. In point of fact some engineers regard the process more as an art than a science, and therefore it is to be expected that there are many divergent views expressed as to the reasons why some extrusions are not so easy as others and perplexing conditions sometime arise.

During the many visits made to extrusion factories and contact with the engineers in their charge, it was the exceptional one which had no problem to solve. From that observation it should be understood, however, that all of the factories visited were in good shape and operating, in many cases, large numbers of extrusion machines very successfully, but there was usually to be found a problem, be it the "know-how" in regard to a difficult shape or material, a question of quality or tolerance on a job, or rate of production. In every instance was shown a keen interest on the part of those responsible to obtain another viewpoint and fresh experience for comparison.

Problems Precede Progress

Problems must of necessity precede progress, and the very statement that in almost every extrusion factory there is to be found a problem indicates a healthy state of affairs. More important still is the increasing awareness on the part of the extrusion machine and equipment manufacturer of this point. This is evidenced by the very close

Figure 1, (left) shows the Windsor R.C. 65 Twin Screw Extruder.

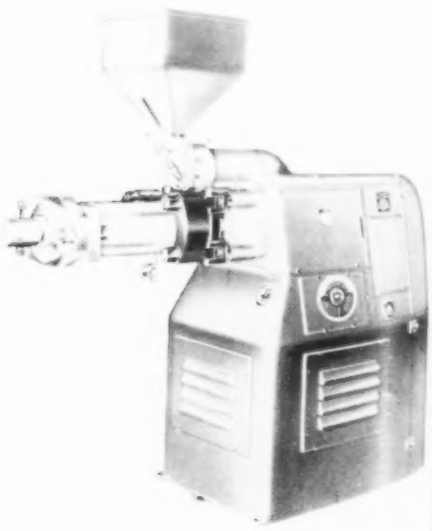

Figure 2 (right) shows the new R.C. 100. MARK II Extrusion machine with improved barrel and die adapter plate arrangements.

In Europe . . . .

An SPE Conference Paper

co-ordination now existing between the leading manufacturers, the extrusion factories and the manufacturers of plastic raw material.

A number of large extrusion machine manufacturers have divided and classified the principle products of extrusion into broad categories, for example, large and small tubes, sections, sheets, blown extrusion and the like, and by close co-operation with the producer have been able to design dies and make and develop complete take-off equipments for the production of a specific product or range of products. In addition there has been a combination of plastics with a number of other basic industries such as paper converting processes and wire covering to name but two, and it should be noted that the specialized experience of those processes have been made available to the plastics industry by a number of link-ups which have been announced, and which now enable those companies who are desirous of combining the several processes to obtain equipment that is completely comprehensive.

This extension of interest and responsibility on the part of the machine manufacturer is bringing about many new developments, many improvements and much "know-how" on the subject of extrusion which would otherwise be lost and thus retard the progress of industry, or would remain confined within much narrower fields.

The problems of the extrusion engineer, resulting from the machine, the die, the take-off equipment, or the final product, are not generally to be solved from theoretical considerations, nor entirely on the design board, and indeed a most effective factor in the progress of extrusion technique is this increasing practical co-operation on the shop-floor between the manufacturer and the user.

Fig. 3. Close-up of Mark II barrel clamp with clamp jaws open.

Cooperation Is Key

An example of this can be seen first in a comparison between the earlier arrangement of the die, barrel and screws on a twin screw extruder and the present modified and improved arrangement.

The earlier arrangement is shown on figure 1, from which it will be noted that the barrel of the extruder, inclusive of the feed aperture, is made in one piece, and is held in position by the die head adaptor plate and tie bars. The heating element is of the sleeve type with a single plug connection, and the adaptor plate is screwed for the fixation of dies by means of an adaptor and collet nut. The extrusion screws are integral with their own driving shafts, and also incorporate the abutments for the thrust forces.

The disadvantages of the above arrangement from the point of view of die adaptation, ease of cleaning, and general maintenance of oil seals and thrust and journal bearings are quite apparent when a comparison is made with the latest arrangement of this manufacture shown on figure 2.

From this photograph it will be noted that the main extrusion barrel has been shortened by the length of the feed portion, and the die adaptor plate modified to comprise two plates, the one made to swing open to facilitate cleaning of the strainer plate assembly, or removal of spoiled material, whilst the fixed plate, being securely fastened to the end of the barrel by high tensile socket head screws, obviates the necessity for tie bars and has completely eliminated the possibility of leaks which had occurred on the earlier design.

As is perhaps known, the cleaning of the twin screw extruder, particularly when considering such materials as acetates, styrenes or polythenes, is much simpler than is the case with single screw machines, and the latest arrangement, figure 3, shows the single swing clamps which have now been fitted to this machine and enable complete clean outs and changing from one material to another in a few minutes.

Sections Easily Removed

A further improvement on this machine, arising out of field experience, is in the sectional arrangement of the gear box, so that the extrusion screws are now attached by muff couplings to their driving shafts, and are therefore readily removed for cleaning or any other purpose whilst the driving shafts and their thrust bearing and oil seal arrangements remain undisturbed.

A further example of development and progress resulting from a close co-operation between the machine manufacturer and the user can be noted in the case of an English manufacturer producing polystyrene molding powder from a battery of triple screw machines. In this instance the machine manufacturer again supplied a packaged unit comprising the extrusion machine, the die, the cooling arrangements and the pelleting machine, all of which are shown in figure 4.

An output of 180 to 200 pounds per hour per unit was envisaged when the first unit was installed, and as a result of close co-operation and study under the settled down conditions of long production runs, it was found that with speed and feed adjustment and small alterations in regard to feed and die design the output could

Production of Large Bore Tubes

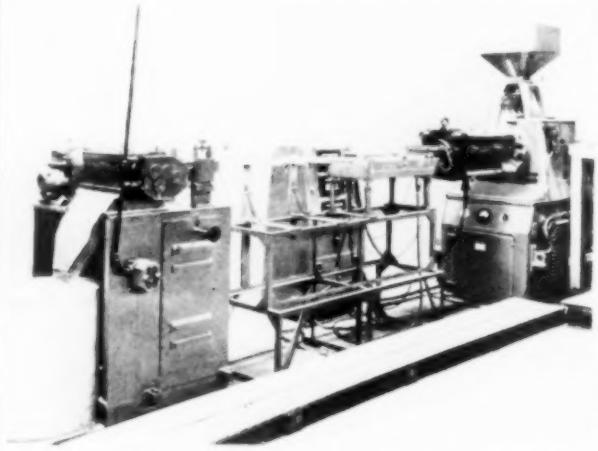

Figure 4. Windsor triple-screw machine and ancillary equipment producing polystyrene molding material.

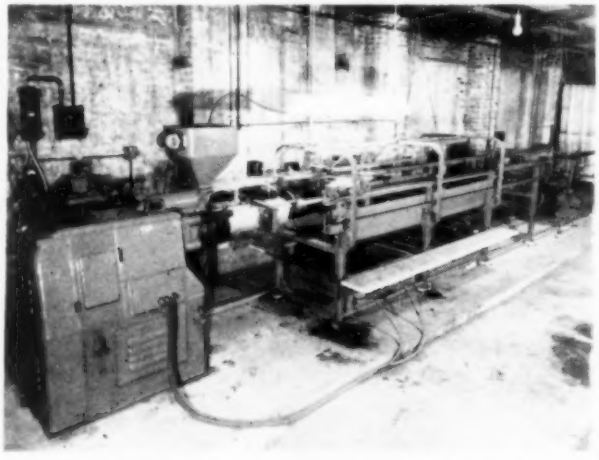

Figure 5. Extruder and take-off equipment producing 6½" outside diameter, 5¾" inside diameter, polyethylene tubing.

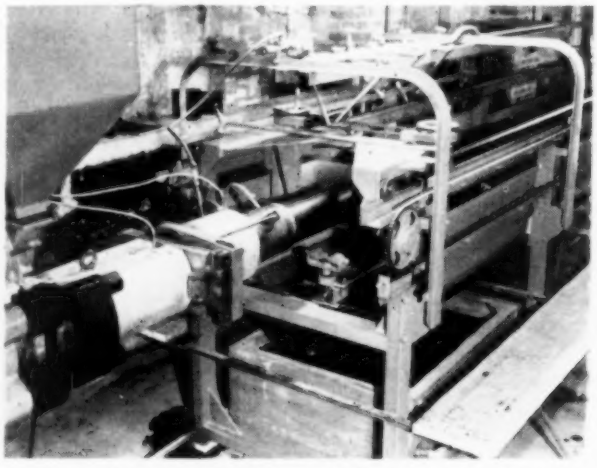

Figure 6. Close-up view of die and former box producing 6½" diameter polyethylene tube.

be considerably augmented. An actual increase of more than 50% was attained.

Large Bore Tubing

In Great Britain increasing use is being made by public authorities of large-bore thick-walled polythene tubing for irrigation and drainage purposes, and a number of concerns are producing this tubing on a more or less continuous basis, many miles of the product being required annually. The actual size of the tube required is 6½" outside diameter, and in regard to which a close tolerance is required since the pipe is ultimately screwed to receive a standard coupling. The bore size is 5¾" with a rather wider tolerance, but with the condition that the wall thickness shall not be less than ⅜", and the tubing is normally cut into 16 foot lengths. The material is a standard grade of polythene to which has been added a small percentage of carbon black for protective purposes against sunlight. Figure 5 shows a typical installation engaged in the production of this tube, the machine employed being of the conventional two screw variety, and equipped with the maker's own design of die and former box, as well as complete take-off equipment.

The method of operation of the extruder and take-off equipment may be of interest and so is briefly described.

Firstly, it will be noted from the photograph that the complete installation is quite a lengthy one, and during the early stages of getting this equipment into production it was found that the accurate lining up of the machine and take-off equipment was of the greatest importance. The extrusion die is of the simplest design, having two blanket type heaters so that the heat input at the back or at the die tip, can be varied at will. The extrusion from the die is slightly less than the finished size required, and immediately in front of the the die face is clamped a water cooled former box bored sufficiently large to allow for the contraction which is quite considerable on the cooling of this size of tube. The former box is not permitted to sit flat on the front face of the die on account of the undesirable cooling effect it would have, and is located on three small projections. A closer view of the die and former box is shown in figure 6.

The large take-off equipment is essentially a trolley runway accurately lined up and positioned on a substantial structural steel frame. The track is equipped with two easy running trolleys, each of which is fitted with a pair of screw operated detachable vice jaws. The rear trolley, figure 7, is also provided with swing latches so that it can be coupled in the manner of rolling stock to the front trolley. The purpose of the trolleys is to grip the extruded tube and flatten it completely in a short length section so that the inflation air which is used for sizing the tube in the water cooled former box at about 5-6 pounds per square inch cannot escape. The trolley is hauled along the track by means of two endless chains which are accurately positioned in relation to each other and are driven through an infinitely variable speed range by means of suitable gearing and speed control equipment of an electrical nature. The power provided is by two 1 h.p. motors having special characteristics, but, as will be appreciated, the function of the pulling trolley is not only that of pulling the tube, but also preventing the tube from being blown and severed at the die by the internal air pressure. The usual cooling water reservoir, circulating pump, sprays and collector trays have been inbuilt in this equipment.

Wide Variety of Extrusions

From a recent opportunity to visit a number of extrusion works in Great Britain and on the Continent, I

was particularly noted that an extremely wide variety of intricate sections, both hollow and solid, were being processed and in many different types of materials, principally in all grades of P.V.C. from the highly plasticized to the completely unplasticized quality, and also in cellulose acetate butyrate, polystyrene and polyethylene. The great majority of the work noted was, however, in the smaller sizes, or at least in the thinner walled extrusion class and a comparison of experience and opinions held by a number of extruders gave the impression that more difficulty is being experienced in the extrusion of solid or relatively thick sections, especially in the easier flowing types such as the acetates and styrenes, than is the case when extruding relatively thin sections.

Some of the hollow sections which were being extruded, and an amazing variety of this type was noted, were extremely intricate, but nevertheless were being extruded with an ease and satisfaction which was almost astounding. The take-off equipment and sizing and general dimensional control arrangements which were in use were in many cases obviously home-made and improvised, but nevertheless extremely excellent extrusions were being obtained and credit must be given to the tool designers and engineers actually on the job. The impression was gained that it is possibly in the thicker and larger, albeit simpler, sections that more of the as yet unsolved extrusion problems lie. There was a very noticeable absence of extrusion machines working on tubes larger than 4" or 5" diameter, or on relatively heavy section work, or of large thick walled sections generally. In Italy, however, an opportunity was afforded to see extrusion machines producing hard P.V.C. tubes in a great variety of sizes and varying wall thicknesses from $\frac{1}{8}$" diameter with an extremely thin wall, up to 15" diameter x $\frac{3}{8}$" wall and even larger. In the same works a number of complicated and larger section extrusions were noted, mainly in hard P.V.C. A wide range of round and square section stock, as well as sheeting, was also being extruded, and are used in the fabricating section where all types of chemical plant is manufactured using the extruded stock as the basic raw material, and which, of course, is principally rigid P.V.C. Among the finished products from this section of the factory were noted complete screw-operated stop valves, rotary ventilator fans, all types of ducting, as well as a wide variety of tanks and vessels entirely formed and fabricated from extruded sheet. Some of this company's products are shown on the cover and in figures 8 and 9.

An extremely interesting example of large crosshead extrusion was noted in the works of a leading Italian extrusion machine manufacturer, the operation in this instance involving the covering of steel tubes with two completely different plastic materials.

Italian Extrusions Interesting

These tubes, which vary in size from 4" diameter upwards and are up to 20' long, have in the past been coated with a bitumastic protection. This protection has been found to be inadequate in view of the ultimate use of the pipes, and after experiment it was discovered that a coating firstly of polythene to a thickness of about 5 mils, and then a further coating of strong P.V.C. to a thickness of between 15 and 20 mils gave complete protection. These pipes are therefore now being covered by extrusion using a specially developed crosshead die with equipment both for feeding the tubes into the extruder and taking away the tube after the covering operation has been performed. An interesting point in regard to this project is that the machine and equipment manufacturer has supplied the equipment for this operation to be performed in the tube makers works, and is also operating a small number of machines in his own

PVC Tubing and Joints

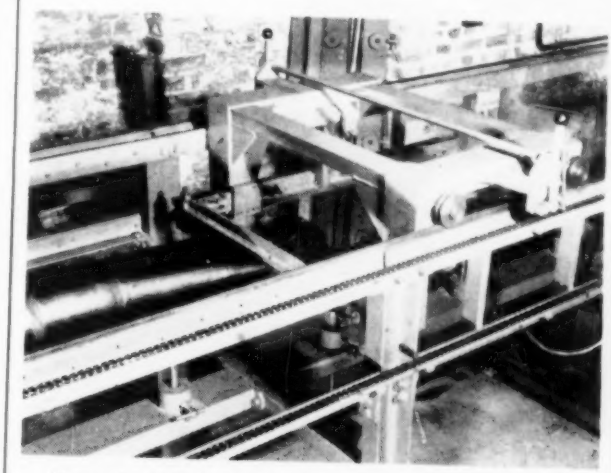

Figure 7. Rear Trolley of large diameter tube take-off.

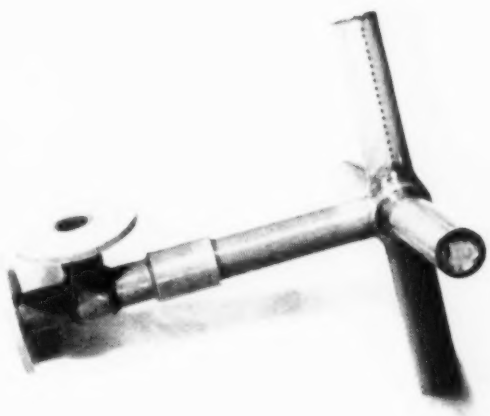

Figure 8. Joints made of PVC tubes. Photo courtesy of Lavorazione Materie Plastiche, Turin.

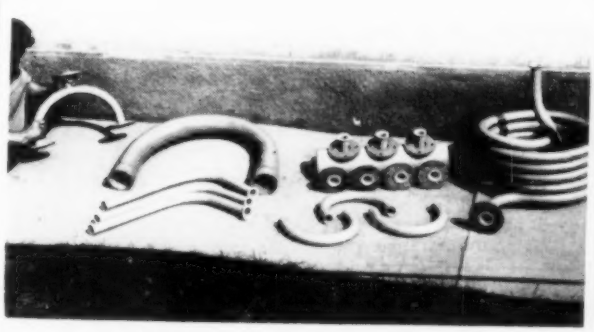

Figure 9. PVC tube bends and joints. Photo courtesy of Lavorazione Materie Plastiche, Turin.

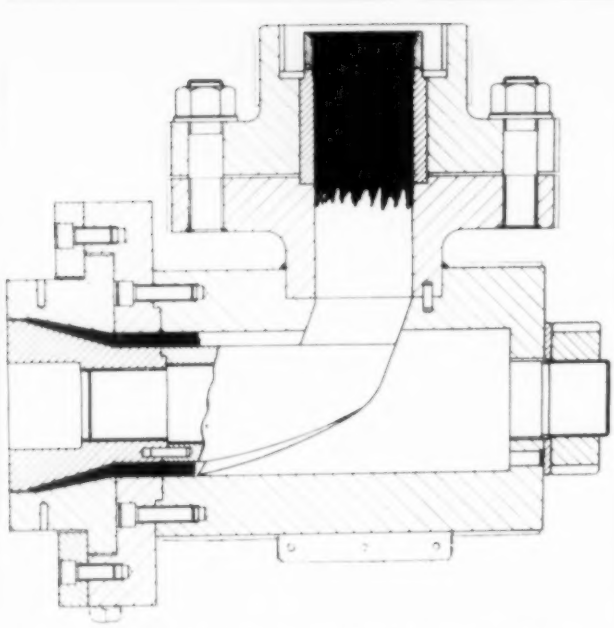

Figure 10. Sketch of a die for producing blown polyethylene film.

works on the same product in order to study the production difficulties, and through a process of development under those conditions evolve the most efficient method and equipment for doing this type of extrusion.

The extrusion of plasticized vinyl sheeting from a round die, and up to 50" wide or more, slitting the product as it emerges from the die orifice, is familiar to most extruders. This product, which has a wide field of application in a soft flexible form, can be embossed with any pattern as desired, or polished using a standard embossing machine, of which many makes are available. It was noted that this production is now being carried a stage further in so far as the extruded sheet is now being backed with linen, felt or other textile material with the use of modified embossing equipment so that the embossing and backing of the extruded sheet is performed simultaneously.

Considerable activity and much interest is being shown all over Europe in regard to the production of blown polyethylene film and also flat polyethylene sheeting produced from a flat die.

Blown Film of Polyethylene

In regard to the production of the blown film, the many schools of thought on this important product seem to have resolved themselves into two similar, though apparently opposite methods, it having been noted that some producers are extruding downwards thus having the added convenience of the take-off controls on the normal floor level, whilst others using almost identical equipment still prefer to extrude upwards where the machine, the die and the heating equipment are more readily accessible.

The basic requirements of die design are now known, and a typical die, figure 10, which is currently in use and producing a satisfactory product is shown. The best method of laying the blown tube flat is now generally accepted to be the provision of sensitively mounted precision ground rollers mounted in a framework so that they can be inclined according to the size of the tubing being produced, at a suitable angle to gradually compress the tube into two flat sheets. The winding of the flattened lay-flat tubing has been noted to be successfully accomplished immediately after the nip rollers and using the actual surface speed of these rollers for the wind up purpose. Other equipment for lay-flat wind up is being manufactured in Europe where the wind up speed is synchronized electrically with the extrusion speed by means of dancer rolls and the slack loop with electrical speed governing arrangements.

Single flat sheet polyethylene is being produced in a wide variety of widths and thicknesses varying from 30-40 mils down to less than 1 mil, and a typical die designed primarily for the production of polyethylene sheeting approximately 30 mils thick x 24" wide is shown in figure 11. The results obtained during the period under observation were interesting, it being found that sheeting of the required thickness could be produced extremely satisfactorily and to close dimensional tolerances. Testing was not carried out under production conditions, but with a laboratory set-up comprising convenient water bath and a set of steel pulling rolls. The water bath was positioned as closely as possible to the die orifice to avoid excessive narrowing on the width of the sheet and to permit suit-

(please turn to page 41)

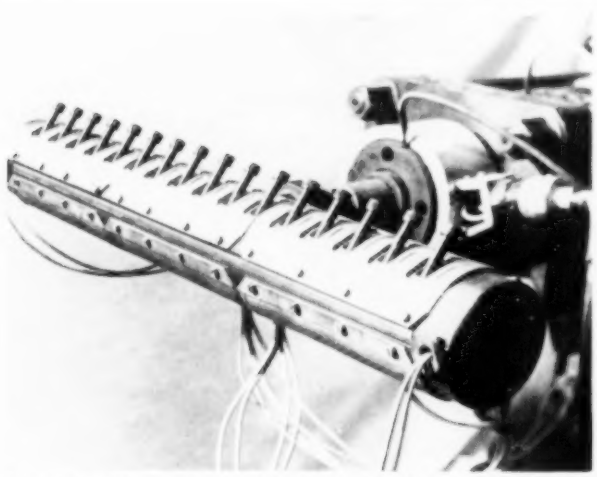

Figure 11. Die for the production of polyethylene sheet 24" wide, 0.030" thick.

Figure 12. Close-up of die with end plate removed.

Liquid Polymers combined with Epoxy Resins

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and

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In its broadest aspects this paper deals with the modified properties which can be obtained from the reaction of liquid poly-epoxide resins and polythiol polysulfide polymers. Epoxy resins are now supplied commercially by a number of companies in the United States: Shell Chemical Corp., Bakelite Co., Division of Union Carbide & Carbon Corp., Ciba Products Co., and Borden Co., Chemical Division. There are also reports that other chemical manufacturers will engage in production of epoxy resins in the not too distant future.

EPOXY RESINS HAVE a number of attributes among which are fast-setting and low-shrinkage properties. As a new member of the rapid-growing plastics-chemical family, the resins have stirred interest in many fields in defense and industry. Much of this interest is due to application possibilities inherent in reactive low viscosity polymeric products which can be converted readily as required in place.

From the nature of the physical properties, it is believed that the structure of amine-converted liquid epoxy resins is a moderately crosslinked lattice. Although the converted resins have fairly good impact resistance, for many applications a much higher degree of flexibility and impact resistance is necessary. Several methods to develop flexibility have been tried, (I) by building a flexible structure within the epoxy resin itself, (II) by using compatible plasticizers, and (III) by using co-reactive flexibilizing resins. Class I products as mentioned above are still in the experimental stage and early attempts have resulted in other physical defects when some flexibility was attained. Class II products are good initially but eventually, under service conditions, the plasticizer is leached out and thus the flexibility imparted cannot be considered permanent. In Class III the final product results from an interaction of polymeric materials involving a poly-epoxide and a polyamide or a polythiol. The polyamides do co-react with epoxy resins and can be considered permanent flexibilizers but polyamides are quite viscous and limited in compatibility with commercial epoxy resins. Polythiol polysulfides appear to have many desirable properties which make them useful in flexibilizing epoxy resins.

Among the advantages to be gained from use of the polysulfides are permanent flexibility, high impact resistance, good aging, and the only water and chemical resistance inherent in the saturated polysulfide elastomeric chain. Application of the products can best be approached from a study of the chemistry involved.

The Chemistry of the Reaction

Epoxy resins are converted to high polymers by the action of nucleophilic reagents, that is, substances which can assume a stable form in which some one of their atoms has a high electron density. Substances such as alcohols, acids, mercaptans, amines, etc. easily relinquish their protons in the presence of bases. The stable anions thus formed are rich in electrons and are therefore nucleophilic.

Conversion occurs according to the following schemes:

(1)

(2)

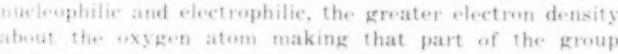
(3)

(4)

Since the flexibilized systems under consideration in this paper contain three components all of which are nucleophilic, we shall consider each component separately.

Mercaptan-terminated polysulfide polymer in the presence of an amine follows reaction (2) to form mercaptide ion.

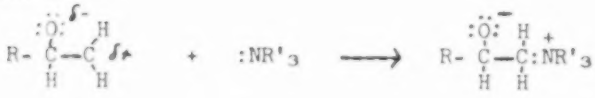
(5)



which can then link two molecules of epoxy resin by following through reactions (3) and (4).

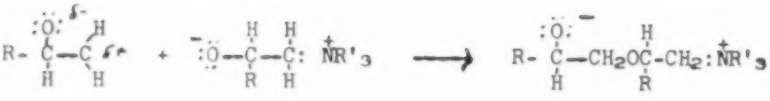
Returning to reaction (1), it will be seen that the resonant hybrid of the epoxy resin terminal can be both nucleophilic and electrophilic, the greater electron density about the oxygen atom making that part of the group nucleophilic and the subsequent dearth of electrons about the terminal carbon making it electrophilic. In the presence of amines, the hybrid form is stabilized by formation of a quaternary ammonium compound:

(6)



The anionic part of the salt molecule thus formed can react with another molecule of epoxy resin according to the following:

(7)



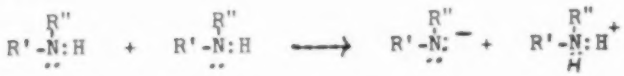
Evidence that this occurs was reported by Narracott[1] in his investigations on phenyl glycidyl ether.

Some commercial epoxy resins are the condensation products of bis-phenol A and epichlorhydrin.

There are hydroxyl groups along the resin chain. These hydroxyl groups can react according to reactions (2), (3), and (4) and form cross-links between epoxy resin chains.

When the base used in the system is a primary or secondary amine, one amine molecule can react with another of the same species to form a nucleophile:

(8)



which can react with an epoxy group as in reactions (3) and (4).

A molecule of a tertiary amine can only react to form a quaternary ammonium compound as in reaction (6).

All of these reactions occurring in the same system tend to complicate matters. Fortunately, the reactivities of hydroxyl, mercaptan and amino groups are not equivalent.

In such systems, hydroxyl groups appear to be the least reactive[4]. The hyroxyl groups present along the resin chain or formed as the result of addition of molecules to the epoxy groups are sterically hindered by chain segments either side of each group thereby decreasing the probability of their entering the reaction picture, at least at room temperature.

The reactivity of amino groups relative to that of mercaptan groups has not been established in our investigations. However, the motility of the molecules of the amines used in these systems is very much greater than that of polysulfide polymer molecules. The net effect, then, is to obtain faster cure rates in systems containing only epoxy resin and amine than in systems consisting solely of epoxy resins and mercaptan terminated polysulfide polymer.

Until now, we have been concerned with the general behavior of the reactive groups involved in the co-polymerization. While this is important in understanding what is happening in these systems during polymerization and to some extent in explaining the behavior of the polymerized material, to the end user of such systems, the most important question is "What effect does the incorporation of 'Thiokol' LP-3 in epoxy resins have on the handling properties of the unpolymerized resin and on the cured material?"

The first effect observed is a lowering of the viscosity of the liquid epoxy resins, most of which are more viscous than LP-3. The action is due only to dilution by a less viscous additive. Typical data are given in Table I.

The physical properties of liquid polymer copolymerized with epoxy resins are reported in Tables II to XI and Figures I to IV. It should be borne in mind that the data reported are typical of LP-3 epoxide cures and are indicative of the trends observed with all commercial epoxides tested thus far. The values reported, however, apply only to the specific combinations described in each table or figure.

Unless otherwise specified, 10 parts by weight of amine to 100 parts by weight of epoxy resins were used as the catalyst. TET stands for triethylene tetramine. DMP-30 is Rohm & Haas technical grade tri-dimethylaminomethyl phenol.

It can be readily seen that increasing the concentration of LP-3 results in lowering the tensile strength and hardness of the cured material while increasing its ultimate elongation.

Proof of the fact that the LP-3 is chemically bound in the cured material is found in the extraction data in Table III. Toluene is an excellent solvent for uncured LP-3 and was therefore used as the extraction medium.

Since we have seen that LP-3 flexibilizes epoxy resins by acting as a chemically bound flexibilizer, the next question which arises is: "What happens to the product at it ages?"

Accelerated aging of the material by heating it at 212°F for seventy hours has resulted in conflicting data which can be explained by returning to the chemical reactions occurring in the mixture. Table IV shows that on heat aging, triethylene tetramine-catalyzed material holds its properties while tri-dimethylaminomethyl phenol catalyzed material softens, loses tensile strength and except for the 2/2 ratio of LP-3/BR-18794 gains in elongation.

If we consider the chemical structures of the amine catalysts used in these mixtures, we find a clue to an explanation of these phenomena. Triethylene tetramine is a straight chain compound having the following formula:

$$H_2N\text{-}CH_2\text{-}CH_2\text{-}NH\text{-}CH_2\text{-}CH_2\text{-}NH\text{-}CH_2\text{-}CH_2\text{-}NH_2$$

A tertiary amino group in this molecule can react according to equation (7) to form a zwitterion which can react to form a covalent bond with any unreacted epoxy group. This covalent bond is thermally stable.

On the other hand, tri-dimethylamino phenol has no available hydrogen on the amino nitrogens and therefore cannot form a covalent bond. The amino nitrogen, however, has an unshared pair of electrons which it can donate to an electrophile and react according to equation (6) to form a coordinate covalent bond which is thermally unstable. Since the three amino groups are projected in three different directions, one molecule can link three epoxy molecules forming cross-links. On heating, these bonds are broken. At the end of the test, as the material cools, these coordinate covalent bonds may or may not reform. Because the polymerized chains are long and have relatively low mobility, the probability that all of the broken bonds will reform on cooling is very small.

This would explain obtaining originally higher tensile strength and hardness with DMP-30 catalyzed cures than with triethylene tetramine-catalyzed cures. The phenomenon limits the use of polytertiary amines as catalysts to applications where temperatures over about 140 F will not be encountered.

One of the most outstanding improvements imparted to epoxy resins by the incorporation of LP-3 is increased impact resistance. Most commercial epoxy resins cure to glass-like materials in which strains develop on cooling. Elastomeric segments interspersed along the chain of cured epoxy molecules relieve the strains set up in the cured material giving the material high impact resistance. See Table V.

TABLE I

	Epon 828	LP-3:828 1:2	LP-3:828 1:1	LP-3:828 2:1	Araldite CN-503	LP-3:503 1:2	LP:503 1:1	LP:503 2:1
Viscosity (Poises)	120	80	17	11	290	52	34.5	25.5

TABLE II

TENSILE STRENGTH, ELONGATION, AND HARDNESS (ASTM D412-41) OF CURED LP-3 BR-18794* MIXES

	Using TET as Catalyst			Using DMP-30 as Catalyst		
Ratio LP-3 BR-18794	1 2	1 1	2 1	1 2	1 1	2 1
Tensile Strength (psi)	2950	950	125	5875	975	475
Elongation, %	20	40	50	0	30	150
Hardness, Shore D	53	39	14	60	48	23

*Bakelite Co., Division of Union Carbide & Carbon.

TABLE III

24 HOUR SOXHLET EXTRACTION IN BOILING TOLUENE (ASTM D297-43T)

	Using TET as Catalyst			Using DMP-30 as Catalyst		
Ratio LP-3 Epon 828*	1 2	1 1	2 1	1 2	1 1	2 1
% Extracted	4.5	4.3	6.7	0.4	1.0	0.9

*Shell Chemical Company

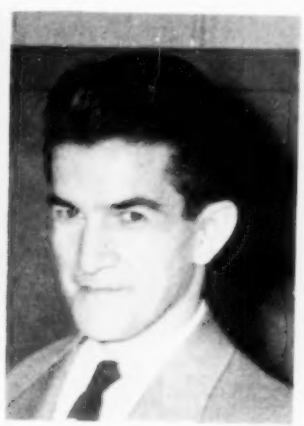
TABLE IV

ACCELERATED HEAT AGING 70 HOURS AT 212 F

	TET-Catalyzed			DMP-30-Catalyzed		
Ratio LP-3 BR-18794	1 2	1 1	2 1	1 2	1 1	2 1
Original Tensile Strength	2950	950	125	5875	975	475
Aged Tensile Strength	4475	1425	75	3450	650	75
Original Elongation, %	20	40	50	0	30	150
Aged Elongation, %	0	30	40	20	50	30
Original Hardness, Shore D	53	39	14	60	48	23
Aged Hardness, Shore D	48	43	13	57	25	13

J. S. Jorczak (left) who resides in Hamilton Square, New Jersey, joined Thiokol Chemical Corp. in 1942 to develop polysulfide rubbers for tire recapping. He is now production manager and technical service manager. J. A. Belisle (right) who was group leader in the technical service department of Thiokol, is now associated with Grumman Aircraft Engineering Corp. This paper was presented at the Tenth S.P.E. Conference in Toronto this January.

J. S. Jorczak



J. A. Belisle

Tests underway at the present time indicate that LP-3 improves the low temperature impact resistance, the low temperature flexibility, and the thermal shock resistance of epoxy resins.

Tests conducted at our laboratories indicate that the incorporation of LP-3 lowers the moisture vapor transmission but increases the water absorption of the cured material. See Table VI and Figures I, II, III, and IV. The result is not unexpected. LP-3 molecules are less polar than epoxy resin molecules. The most generally accepted theory on the mechanism of moisture vapor transmission is that water molecules move from one polar group to another. Water molecules should move quite readily in a mass of tightly-knit, highly polar molecules as is found in cured epoxy resin. If, however, amorphous, less polar molecules are introduced, the polar molecules are diluted and the structure is loosened. Therefore the moisture vapor transmission is decreased. However, on immersion in water, the looser structure allows the absorption of a larger amount of water molecules into the resulting interstices in the lattice.

It can be seen from the above data that the liquid polymers can be used in a number of ways to modify commercial epoxy resins.

The earliest large scale acceptance of epoxy resins was developed by reacting them with low cost drying oils and using the product in high quality alkyd-type paints. Only a few years ago, liquid epoxy resins were hardly more than experimental. They were not available in quantity and were not considered practical or uniform for production. During the past two years, marked improvement has been made and the resins which are now available are well controlled. The polysulfide liquid polymers have been commercially supplied since 1942 and have been used in defense and in industrial applications where very critical and close requirements have to be met.

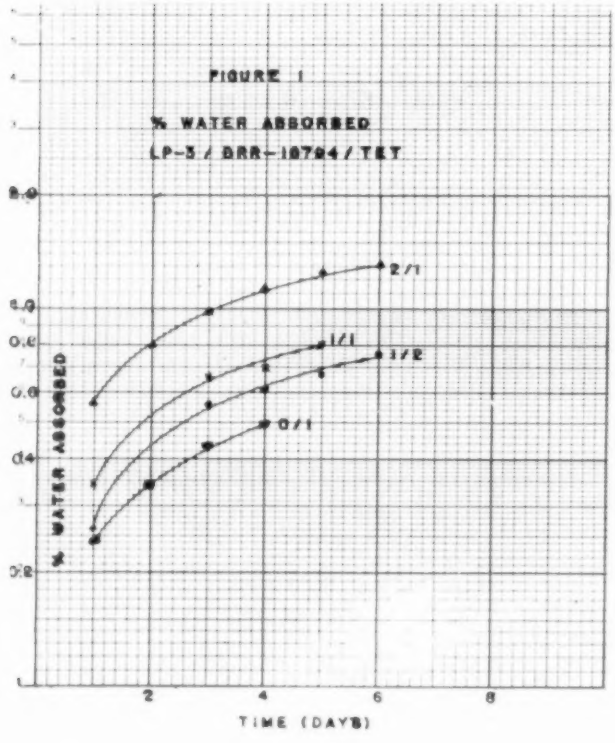
Casting and Embedment

Once the liquid epoxy resins were more available to the market, one fairly obvious choice for development work was to apply them as casting or embedment resins. The resins have good electrical properties and can withstand service over a wide temperature range. In some cases, the resins can be used without modification, but in many applications, the casting will crack due to high internal stress; or delicate components of the embedded assembly will break due to pressure resulting from shrinkage during conversion. To correct these conditions, polysulfide liquid polymers can be added to the formulation. The degree of flexibility imparted can be controlled by selecting the concentration of liquid polymer to be used. In most jobs it is desirable to copolymerize the resin and elastomer at ambient or moderately elevated temperatures. Liquid amines are used as catalysts to control the conversion. If the amine is soluble in the polysulfide liquid polymer it can be masterbatched and the solution can then be added to the epoxy resin. Mixing and control of critical amine concentrations can be facilitated by this method.

Adhesives

Liquid epoxy resins have been used in fast setting adhesive compounds. The basic structure of the resins contributes to development of adhesion to almost any clean surface. Compounding improves the wetting properties and application at 100% solids permits quick and permanent bonding of impermeable building materials such as glass, ceramics, metal, etc. Improved bond strengths can be obtained by careful attention to surface cleaning.

Thiokol-Epoxy Water Absorption Characteristics



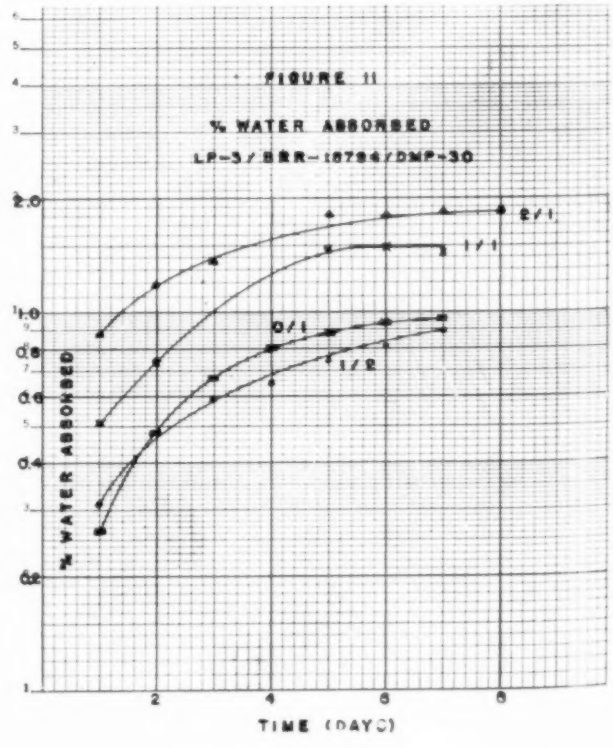


TABLE V

IMPACT RESISTANCE[1]
FOOT-POUNDS

	TET Catalyst				DMP-30 Catalyst			
LP-3 Epoxide Ratio								
With CX-503	0/1	1/2	1/1	2/1	0/1	1/2	1/1	2/1
Impact withstood	1.3	78.2	78.2	78.2	——	0.6	78.2	78.2
Impact failed	2.2	——	——	——	0.4	0.8	——	——
With Araldite KD-133								
Impact withstood	2.6	23.9	78.2	78.2	——	——	8.0	78.2
Impact failed	2.8	26.9	——	——	0.4	0.4	11.9	——
With BR-18794								
Impact withstood	2.9	63.5	78.2	78.2	0.4	2.3	75.3	78.2
Impact failed	3.7	71.3	——	——	1.0	2.7	78.2	——
With Epon 828								
Impact withstood	1.0	43	78.2	78.2	0.48	0.9	56.5	78.2
Impact failed	1.5	51.8	——	——	0.50	1.4	65.9	——

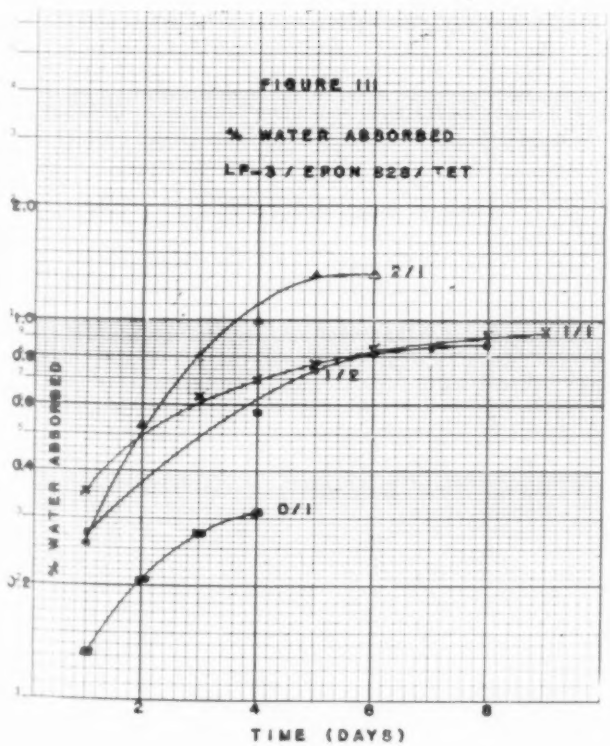
[1] Test apparatus and procedure described in U. S. Navy Specifications MIL-C-16923 (Ships) for plastics. The maximum force at impact obtainable by our apparatus is 78.2 ft. lbs.

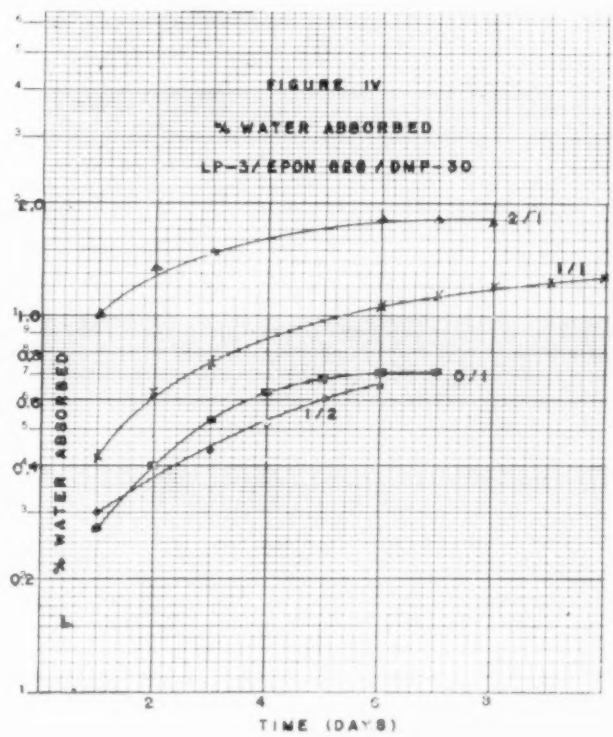
TABLE VI

MOISTURE VAPOR TRANSMISSION (ASTM D814-46T)
(fl. oz. ft.^{2}/24 hrs.)

	DMP-30 Catalyst			
LP-3 Epoxide Ratio	0/1	1/2	1/1	2/1
with Araldite CX-503	0.136	0.045	0.009	0.008
with BRR-18794	0.162	0.037	0.004	0.003
with Epon 828	0.057	0.057	0.008	0.003

Thiokol-Epoxy Water Absorption Characteristics





In the case of metals, chromic acid etching is desirable. Rubber surfaces must be cyclized with sulfuric acid or the resin will not adhere. The main weaknesses in the resins lie in poor adhesion in peel and thermal softening accompanied by creep at temperatures over 160°F.

Use of polysulfide liquid polymers in the epoxy resin reduces internal strain in the copolymer and improves wetting properties lacking in some of the commercial resins. The thermal softening and creep characteristics are not improved and high concentrations of liquid polymer in the copolymer will cause thermal softening and creep at lower temperatures than that shown for the resin itself.

Laminates

Epoxy resins have been used with glass mat and fiberglas cloth to make high strength low pressure laminates. Both cast resins and laminates have been used in forming tools and dies for the automotive industry. Undoubtedly, epoxy fiberglas laminates are under test as component parts of plastic automobile bodies for sports cars. Also, there is a big market for plastic fiberglas pipe for the oil, chemical and other industries. Even with serious deficiencies, polyester resin fiberglas pipe is already used in quantity.

Internal strains seem to weaken the resin laminate structures prematurely. The improved impact strength and reduced shrinkage factors imparted to the copolymer by the polysulfide liquid polymer should improve the laminates for many applications.

Above values were obtained on ⅛ inch low pressure laminates using 12 plies of Owens Corning 181-144 glass cloth. The laminates were prepared by painting both sides

TABLE VIII

TYPICAL ADHESIVE FORMULATIONS & PROPERTIES

	No. 1	No. 2
LP-3	100	100
Epon-828	100	100
CN-504	100	—
CN-503	—	25
Burgess Pigment No. 20	150	112.5
DMP-30	15	10
Shear Strength of Aluminum to Aluminum		
Shear Strength, lb. sq. in.		
24 hr. cure @ R.T.	2270	1700
72 hr. cure @ R.T.	2880	2880
24 hr. cure @ R.T. +		
1 hr. @ 158°F	3210	2600
1 hr. @ 230°F	4200	—
Shear Strength of Various Surfaces		
Shear Strength, lb. sq. in.		
½ hr. cure @ 250°F		
Aluminum to wood	810 WF	970 WF
Aluminum to glass	250 GF	240 GF
Peel Bond Strength of Tin to Tin		
½ hr. cure @ 250°F	22.5	35

WF—Wood failure
GF—Glass failure

TABLE VII

TYPICAL CASTING FORMULATIONS AND PROPERTIES

	Epon 828 —60 LP-33 —40 TET — 6	BRR-18794 —50 LP-33 —50 TET — 5	Araldite KD-133 —60 LP-33 —40 TET — 6
Viscosity (poises @ 77°F)	19	20	19
Pot life approx.	30 min.	30 min.	30 min.
Gel time	1 hr.	1 hr.	1 hr.
Cure time (tack free)	3 to 4 hrs.	3 to 4 hrs.	3 to 4 hrs.
Physical Properties			
24 hrs. @ 80°F			
Tensile strength, p.s.i.	1700	1100	400
% Elongation	40	40	100
Hardness Shore D	48	39	25
24 hrs. @ 80°F plus 70 hrs. @ 212°F			
Tensile strength, p.s.i.	1900	1700	900
% Elongation	30	30	60
Hardness Shore D	50	43	39
24 hrs. @ 80°F plus 2 months @ 212°F			
Tensile strength, p.s.i.	1900	2200	1600
% Elongation	30	30	40
Hardness Shore D	50	50	50
% Extractables in Soxhlet using boiling Toluene for 24 hrs.	4%	7%	9%
Wt. loss @ 212°F to reach constant weight			
% Loss number days	1% 7 days	1% 7 days	7% 22 days

TABLE IX

TYPICAL RESULTS WITH LAMINATE STRUCTURES

LP-3	100	100	100	100
-28	300	400	500	600
DMP-10	30	40	50	60
Total resin content of laminate	20	29	27	24
Dielectric constant	4.2	4.0	4.0	3.0
Loss tangent	.016	.014	.014	0.12
Flexural Strength* psi	57,000	53,000	54,000	56,000
Modulus of Elasticity* in flexure, psi	3.7×10^6	3.4×10^6	3.9×10^6	2.9×10^6

*Values appear somewhat out of line but are reported here as observed.

of the bottom ply of cloth and then upon each successive ply, the top surface was painted with the mixed compound. The assembly was cured 30 minutes at about 250°F.

Protective Coatings

Thiokol Chemical Corporation laboratories are now working on air drying paints at close to, or at 100% solids. The objective is to apply a protective coating in a one coat application. The copolymer of epoxide resin - liquid polysulfide should form a well integrated film, free of holidays. When the film is air dried, its properties are similar to those of a baked phenolic resin. The good adhesive properties of the mixture should provide good bonding to roughly prepared surfaces. It is hoped that wire brushing to remove loose paint and scale will be adequate for surface preparation.

Although the materials are costly, one coat can be applied to any desired coating thickness. Reduced cleaning and application costs should offset the higher material cost. If the experimental program is successful, the protective coatings should be useful in the chemical and marine industries. Some of the properties listed below in tables X and XI are responsible for our interest in this development.

Summary

Coreaction of epoxy resins with polysulfide liquid polymers results in products having many properties better than either polymeric product by itself. Epoxy resins convert to a strained lattice structure. Polysulfide liquid polymers are saturated elastomeric chains which convert to soft rubbers having good aging, oil and water resistance. When these two basic products are combined, a wide range of properties can be had by selection of the concentration of the two ingredients. Essentially, the polysulfides are used as modifiers for the epoxy resins, contributing lower shrinkage, lower strain, greater and permanent flexibility, much higher impact resistance, lower moisture vapor transmission, lower pouring viscosity and better peel strength in adhesion.

Results on some of these properties have been shown in the tables. The most recent information centers around measurements of impact resistance, moisture absorption and vapor transmission and these properties are treated in detail.

Epoxy resins are comparatively new in the field of resins and plastics but they have created an abnormal amount of interest and activity. The response on the part of many industries to these resins indicates the possibilities open for other reactive liquid resins.

Liquid polysulfide polymers appear to fit naturally into the epoxy application picture. Permanent flexibility, low strain, and low viscosity make liquid polymers useful in embedment and casting applications. Low strain, flexibility and improved wetting properties conferred by polysulfide liquid polymers improve epoxy adhesives. High impact resistance and lower shrinkage imparted by poly-

(please turn to page 38)

TABLE X

SOLVENT SWELL (1 WEEK-1 MONTH,) % (ASTM D471-51T METHOD B)

Ratio LP3-Epoxide	1-2	1-1
Benzene	2-30	38-81
Xylene	-2-0	1-2
Toluene	0-15	10-14
Acetone	24-17	8-7
MEK	28-20	28-27
MIK	-2-2	0-2
CCl	2-3	-2-6
Ethyl Acetate	3-21	13-17
Pyridine	-2-2	1-2
SR-6	-2-2	0-1
SR-10	2-2	0-0
H-O	2-2	1-2

TABLE XI

CHEMICAL RESISTANCE AFTER 1 MONTH

LP Epoxide Ratio	1-2	1-1
10% HCl	OK	OK
30% HCl	slightly blistered	blistered
20% HNO_3	blistered	disintegrated
60% HNO_3	disintegrated	disintegrated
20% H_2SO_4	OK	OK
60% H_2SO_4	OK	cracked
10% NaOH	OK	OK
50% NaOH	OK	OK
Dibutyl Phthalate	OK	OK
Sat'd Na_2CO_3	OK	OK
Sat'd NaCl	OK	OK
Sat'd $Al_2(SO_4)_3$	OK	OK

THE *Injection* MOLDERSCOPE

By A. R. Morse

President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

The October, 1953 issue of Modern Plastics magazine contains an article on injection mold temperature control by Carl Whitlock. The Molderscope takes this opportunity to review some of the historical detail on this problem. The history of injection mold temperature control began when J. E. Wolfe of Meridian Plastics Co., Byesville, Ohio developed the original Meridian Circulator for his own use. Lax Davenport and the old Continental Can (then Reynolds Spring Co.) also figured in the early history of this pioneer unit. The original Meridian Circulator consisted of two upright tanks, containing heating elements. Two heat ranges were offered, 50-250° for water and 200-500° for oil. A few single tank models were made. From 1939 to around 1944, Meridian was the only commercial supplier.

The next commercial mold temperature control unit in point of time to appear was made by Improved Machinery Co. of Nashua, N. H. This was a round tank with immersion heaters and which was made in various sizes. Then for three or four years more, Meridian and IMPCO made the only commercial circulators. Finally, Youngstown Miller put one out, but it never enjoyed much recognition. As time passed, need for greater control of the injection mold was seen. Jobs were now adding heat to the mold. The advent of styrene on a large scale in 1946-47, changed many things in injection molding, among them our basic concepts of mold temperature regulation.

The first concern to perceive this and do something about it was Industrial Heater Mfg. Co. of Indianapolis, who at Amos Molded, pioneered a new idea — heating AND cooling of the injection mold. Essential to the success of modern injection mold temperature control was a large volume of circulating medium, and larger, better arranged mold passages, and Industrial Heater did much to spread this basic concept. Their circulator then and now uses a solenoid actuated control valve to admit cold water to the circuit when needed. The Industrial unit was priced at more than twice the cost of the Meridian and Impco and did an excellent job on many then new, large styrene jobs where other earlier circulators were inadequate.

Soon after the appearance of the Industrial Heater unit, Impco added cooling coils to their unit to adapt it to the new conditions and the Meridian was also re-designed to incorporate modulating valves so that both heating and cooling could be done simultaneously with a circulating medium that was held at an even temperature, regardless of whether the mold added heat to, or took it away from the water passing through it. In the course of inquiry about modulating valves, Meridian introduced a Milwaukee concern, Sterling Inc., to the injection field. At first, Sterling endeavored to place its controls on the oil cooling circuits of injection machines, but since the oil cooling of presses is usually inadequate, it proved of uncertain benefit to try and conserve oil cooler water when usually more was needed. The company then developed a mold circulator patterned very closely after the re-designed Meridian, using Thermostatic modulating valves to control the cooling feature instead of the solenoid type valves of the Industrial Heater type circuit.

Finally in 1953, the Sarco Company of New York offered a circulator using the same general type of circuit as the Industrial Heater, except that cooling was accomplished by a built-in coil, so the circulating medium is not diluted.

In 1949, Injection Molders Supply Co. introduced a new idea in mold temperature control, called a Mold Discharge Regulator, where a thermostatic valve is used to dam up mold heat until it reaches a set point, when the valve opens and allows a trickle of new water to enter the mold as needed. This device was very quickly copied by Sarco and offered to the trade using their valve instead of the Powers valve used in the IMS unit. The IMS unit was developed by Arnold Kincaid of Powers Regulator Co. who first conceived the idea of using the mold generated heat latent in the mold cooling water to regulate the volume of flow of water through the mold and hence its temperature.

Injection Molders Supply Co. of Cleveland next introduced a small compact, low cost injection mold circulator as has Thoreson-McCosh Inc. of Detroit. These small, less expensive units are designed to bring the injection mold circulator within the range of the average molder, as larger units run upwards from $1000 and these new models are both under $500.

There are in reality only three types of circulators on the market. All use identical or similar heaters, controls, valves, etc., and all function in the same general way. The worst problem in the field is the pump and pump packing and rust together with pump maintenance and electrical deficiencies comprise the worst bugs in all circulators.

The three types of circulators in use are:

1.) The cooling coil or closed circuit type, where cooling water is introduced through coils that transmit a chill to the circulating medium, but do not dilute it. Units like the new IMS, the Sarco and Impco follow this design trend.

2.) The Meridian and Sterling type which uses the thermostatic valves to introduce cooling water when needed causing excess water to flow to drain. On these circulators, water cannot reach the mold unless it first attains the set heat and passes through the thermostatic regulating valve.

3.) The Industrial Heater type unit which uses solenoid valves to momentarily introduce the cooling medium in small flushes when needed.

Therefore, you have the following concerns listed in order of entry into the circulator business offering commercial injection mold circulators. The chief variation in circulators today therefore is in the overhead of the manufacturing concern and in the amount of type of sales and commission expense used to promote it to the injection molders' attention.

Plastic Machinery Inc., (Meridian) distributed by Injection Molders Supply Co. and representatives.

Improved Machinery Co., (Impco Circulators) distributed through Impco representatives.

Industrial Heater Co. (Thermolator) distributed direct and through representatives.

Sterling Inc., (Sterling) distributed direct and through representatives.

Sarco Inc., (Sarco) distributed direct and through representatives.

Low Cost Units:

Injection Molders Supply Co., distributed direct and through representatives.

Thoreson McCosh Inc., distributed direct and through representatives.

AUSTRALIA

AUSTRALIAN PLASTICS

Vol. 8, No. 98, Sept. 1953

Abstracter: Albert Lightbody

POLYSTYRENE AND SOME RECENT DEVELOPMENTS. By C. D. Goodchild. (p. 6-11)

A discussion of the properties and uses of polystyrene as well as the techniques of annealing, dry coloring and metallizing. The new types of impact and heat resistant polystyrene are also covered.

OVERSEAS TREND IN THE DEVELOPMENT OF PVC. By K. A. Butcher. (p. 17-18)

Per capita usage of PVC in the U. S. is 2.2 lbs. in 1952 while in the U. K. it has reached 1. 5 lbs. The largest single application is in unsupported film. Uses are given which extend from baby wear to underground silos. Application for rigid PVC sheeting is also growing in such uses as refrigerator panels, miners helmets, etc. Other large uses are floor coverings, conveyor belts, cable covering, plastic pipe and gramophone records.

AN ECONOMICS PRODUCTION TOOL FOR MOLD AND DIE MAKING. (p. 25-26)

A description of the construction and operation of the German "Deckel" universal duplicating milling machine.

THE PLASTIC LOUVERALL CEILING. By J. J. Grundfest. (p. 31-33)

The use of plastics louvres to cover the entire ceiling is discussed. Advantages are the reduction of eye strain due to glare. Molded polystyrene gives a lightweight, efficient and low cost ceiling which is finding considerable usage.

THERMOPLASTICS IN RESILIENT CONCRETE. By N. W. Farmer. (p. 34)

Reprint from "SPE Journal."

PLASTICS NEWS FROM BRITAIN. (p. 37)

The work at the Royal Aircraft Establishment at Farnborough on high speed electric shock cure of phenolic laminates shows considerable promise as a surge of electrical current through the molding material cures the resin in a few seconds. This is accomplished with A. C. current with 230 volts passed through the material via the platens.

PLASTICS NEWS LETTER (PIA)

Vol. 3, No. 8, October 1953

THE STABILITY OF POLYVINYL CHLORIDE PASTE. By G. Lane. (p. 1-3)

The effect of the various factors affecting the time between the mixing and the use of the vinyl resins is discussed. These factors are the resin, the plasticizer, pigments, diluents, and the mixing and storage conditions.

BELGIUM

MATIERES PLASTIQUES ET RESINES SYNTHETIQUES

No. 66, Sept.-Oct. 1953

Abstracter: A. P. Daignaault

USE OF RIGID PVC SHEET

A short description of various uses of rigid PVC such as equipment for the chemical industry, decorative panels, reflectors for fluorescent fixtures, refrigerator door panels, trays and tote boxes, safety helmets, drawing instruments, displays, and various aviation applications.

USE OF METAL AND PLASTIC PATTERNS IN THE AUTOMOBILE INDUSTRY

Savings realized by the Chrysler Corporation in time, material and labor by use of "Tool Plastic" amounting up to 50% of cost of previously used metal patterns.

POSSIBILITIES OF PLASTIGELS

A short description of plastigels and their uses based on an article by Edward T. Severs in SPE Journal, June 1953.

PLASTICS IN FRANCE

Describes a new store in Lyon, France ("Maison Synthex") where only plastic products are sold. As much as possible plastic materials have been used in decorating the store. It is the desire of the creator of this establishment, not only to sell plastic products but to educate the consumer as to the properties and care of the items.

PLASTIC APPLICATIONS

Short descriptions and photographs of (1) Tie supports for railways of vinyl resins and banana fibers (2) laminated vinyl lamp shades (3) Polyethylene coated Kraft containers for chemicals (4) a new method of forming dental plates using vinyl sheet, (5) Decorative articles.

METALIZATION OF PLASTICS

Reprint of an article by Dr. Harold Narcus in SPE Journal, March, 1953.

CANADA

CANADIAN PLASTICS

July-August 1953

Abstracter: Harriman H. Dash

WATER MAIN IN CELLULOSE ACETATE

A brief description of the installation of Tenite piping at Neubstadt, Indiana. Ease of handling, quick assembly, corrosion resistance, and delivery of 40% more water are the advantages claimed for plastic over steel piping.

FORMING OF BRITISH RIGID VINYL SHEET

Discusses the fabrication of Cobex (British Xylenite Co.), a vinyl chloride - vinylidene chloride copolymer sheet in sizes up to 4 x 8 feet and thicknesses from .010 to .500". Transparent, opaque, colored, plain, and embossed sheet stocks are available. A brief description of the properties and the precautions in handling the sheet are presented. Draw forming is accomplished by uniformly heating the sheet to 300 F and applying the standard techniques of vacuum, matched mold, or compressed air. Excellent forming detail is possible which makes the material suitable for engraving and electrotyping plates. Directions for conventional fabrication methods

(sawing, drilling, routing, tapping, etc.) are given in varying detail.

ENGINEERED POLYESTERS FOR CANADIAN-MADE RADOMS

This paper discusses the operation of the Brunswick-Balke-Collender Co. of Canada for the production of high strength, dimensionally stable and accurate polyester-reinforced radoms. Materials, formulations, and test panels undergo complete laboratory checks prior to production runs. Radom production ranges from small 3 inch units to large plane noses, all kept to a tolerance of .0015". Outer and inner skins are formed by matched mold techniques employing 60-70% glass cloth, and 30-40% resin by weight. The foamed core is produced between the skins in a 3 story press. The "rough" stage is then calipered and finished. Other operations conducted at the plant are application of Neoprene coatings, vacuum bag moldings of wing tips, research and development in rubber, vinyls, phenolics, etc.

B. A. SHAWINIGAN

The world's first plant for the production of phenol and acetone from petroleum has been set by the Shawinigan at Montreal East. The plant uses a licensed Hercules process. Benzene is alkylated with propylene; the product is oxidized to form cumene hydroperoxide which is then catalytically split to form phenol and acetone. Approximately 13 million pounds of phenol and 8 million of acetone are expected annually. Alphamethyl styrene, acetophenone, and mesityl oxide are by-products. The process has distinct advantages for Canada which has large domestic sources of petroleum and expanding needs for the products. The plastics industry should provide one of the major markets for the process products.

SURGICAL REPAIRS WITH PLASTICS—Dr. W. Schweisheimer

This article reports on the first artificial heart valve used in a human being. The valve consists of an acrylate "pea" ball float inside of a chambered polyethylene tube connected to the aorta. The acrylate replaces other products (glass, stainless steel, vitallium) formerly used in dog experiments but which caused clotting. Nylon and some vinyls have also been found suitable for internal body use. Other surgical cases successfully using plastic tubing are intestinal obstruction, blood infusion, ascites. Plastics are also used for superior surgical instruments (brain retractors, spoons, mallets, eye enucleators.)

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FRANCE

INDUSTRIES DES PLASTIQUES MODERNES

Vol. 5, No. 9, Nov. 1953

Abstracter: Hans Mayer

MANUFACTURING AND THE MARKET FOR LARGE INJECTION MOLDED PARTS. By Jacques Combette.

The author discusses the advantage of tooling up for large injection molded parts if a large enough market can be developed to amortize the necessary equipment within a reasonable period of time. He demonstrates the feasibility of doing so on a number of parts and also pictures the difficulties of setting up molding operations of this scope within the economy which is limited in size and where the number of competitors is comparatively large.

THE 19th BOATS SHOW.

Glass reinforced polyester boats, plastic light weight furniture, accessories for fishing, life saving equipment, and beach accessories were on display.

A NEW POLYETHYLENE CLOSURE FOR CHAMPAGNE. (Sparkling wine).

The design and tests on a polyethylene closure for champagne bottles are described, and promise is made that this innovation will not only be advantageous for the quality of the product, for the cost picture of the bottling plant, but will also make it possible to close the bottle after using part of the content only.

LARGE POSSIBILITIES FOR ADHESIVE TAPES.

The adhesive tapes are classified as follows: reacting to a solvent, heat reacting, contact adhesives, and adhesives which attach themselves to materials of the same classification only. Products of this type, made from polyesters, acetates, vinyls, etc. are discussed and their source of supply and usage in the U.S.A. is described.

THE MARKING OF SHEETS BY HIGH FREQUENCY. By J. Brandenburger.

The marking of sheets and films which are heated by high frequency results in defective parts. This is due to the type of dies being used. A method of using aluminum dies mounted on aluminum platens or using aluminum dies and compressed air for cooling the die which will overcome the present difficulties is described.

CHOCK CONCENTRATE FOR POLYSTYRENES. By H. De Fresia and A. Destable.

The Kayson Rubber & Plastics Ltd. of Canada has developed a copolymer which can be added to standard polystyrene molding powder in dry form, either before or after the material has been colored. The qualities of the mix as to check resistance, moldability, flexibility, etc. depend on the percentage of the copolymer added.

PLASTICITY OF THERMOSETTING MATERIALS IN THE COURSE OF THE MOLDING OPERATION. By M. Chatain.

Discusses the setup and instrumentation necessary for this investigation.

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GERMANY

KUNSTSTOFFE

Vol. 43, No. 11, November 1953

Abstracter: Anne Schwend

ACOUSTICS AND PLASTICS. By Dr. Hermann Oberst.

A detailed survey on the applicability of plastic materials in electroacoustics (magnetic tape, transcription records, electro-acoustical transducers, phonographic pick-ups, loud speakers, coating of paper diaphragms and screening of the film to obtain a uniform sound radiation) in shock- and oscillation damping (screen machine-bed vibrations from surroundings, use of rubber and plastic spring elements in setting up machinery, vulcanization of rubber damping elements to metal parts setting the fastening or screwing together of two machine parts, foamed plastics for vibrationless setting up of laboratory instruments) and in the building industry (sound deadening in rooms and prevention of sound and vibration transfer into neighboring rooms through use of various plastics). Since vibration damping by means of so-called non-reverberating coatings gains in importance more and more, this subject is discussed in detail comprising ways of measuring, application to various base materials and adaptation of these non-reverberation-eliminating materials to exigencies by increasing their inner damping qualities through proper choice of amount of plasticizer and fillers.

CRYSTALLATION EFFECTS IN PLASTICS. By Dr. Ernst Jenckel.

An address held at the 1953 Plastics Convention in Hamburg. Analogous to extensive research work in the field of the structure of metals during the past three decades, the tendency of certain high polymer

...ulize has been given much ... recently. Knowledge of the ... of materials permits to ... conclusions as to their mech... action and other features of ... to the user. There is quite a ... of materials showing crystal... effects, such as polyethylene, ... polyamides, polyurethane and ... as well as polyterephthalic ... rubber and guttapercha. ... alluding to the theories of Flory ... Ueberreiter, the author ventilates ... theory that the melting and ... crystallisation process of high poly... is a one-phase transformation ... of bi-phase. The kinetics of ... crystallization and forming of crys... in strongly sub-cooled melts, ... of crystallization dependent on ... viscosity of the melt and the temp... effects little below the melting ... it was observed that by ... tempering of normally ... and crystallized polyurethane ... a further decrease in volume ... be obtained and an increase of ... crystalline structure through ... observed — and the crys... in little sub-cooled melts ... discussed. The experiments des... show that upon cooling down ... polymers crystallization takes ... rather far below the maximum ... point. Melting down, how... occurs at a higher temperature ... so much higher the slowlier ... is being heated, in other ... the longer tempering lasts. ... a typical proof for hysterisis ... is characteristical for one-... transformations. Also dis... are the viscosity near the ... point as well as the forma... spherulites and transcrystalli... in polyurethanes and polya...

PLASTICS CONVENTION 1953 IN HAMBURG.

A brief on the introductory addresses at the opening of the Plastics Convention. Addresses of technical contents will be published in the December issue of Kunstoffe.

7th MEETING OF THE SOCIETY OF GERMAN CHEMISTS, PLASTICS AND CAOUTSHOUC GROUP IN HAMBURG, SEPTEMBER, 1953.

A brief on addresses held at the meeting:

Dr. van Alphen, Holland: Present-day knowledge about the vulcanization process.

Dr. P. Schneider, Leverkusen: Remedies for ageing and their influence on the oxidation of caoutchouc and caoutchouc vulcanization.

Dr. W. Kammerer, Mainz: Reaction kinetics upon condensation of phenolic resins.

G. Eier, Frankfurt Main: Production and properties of polymerizers containing fluorides.

Prof. Dr. Schulz, Mainz: Density measuring of and disorder in high polymers.

Prof. Dr. Stuart, Hanover: Texture of crystalline high polymers made visible by an electronic microscope.

INTERNATIONAL PLASTICS STANDARDIZATION.

Summary of the points of discussion and agreements reached by the ISO TC 61, Plastics Groups, at Stockholm in August 1953.

RECENT EXPERIENCES IN THE DESIGN OF EXTRUDER HEADS AND DIES. Br. Ing. A. Romanowski, Hanover.

A survey on the design of tube extrusion heads, crosshead extrusion dies and blow molds as well as broad slot dies, as presently offered on the German market, is given. Much of the information corresponds to that presented by Mr. S. H. Greenwood in his paper on multi-screw extrusion of rigid vinyls and die design at the 9th SPE Conference. The design of the orifice and the land length is particularly emphasized and explained with the help of examples. Chilling, landing and take-up devices are discussed.

FEEDING AND HEATING OF EXTRUDERS. By H. Reifenhauser, Troisdorf.

A compendium of details on the preparation of thermoplastic materials by way of preplasticizing, gelatinizing, granulating, preheating and drying for feeding them into an extruder, size of the feed port opening in the barrel (minimum length should be equal to the pitch of the screw), similar sub-division of the plasticizing extruder into various zones as that presented by Mr. J. M. McKelvey at the 9th SPE Conference, showing in addition a cooling section arranged immediately behind the feed pick-up section, the temperature of the cooling agent being adjustable according to the kind of material to be extruded. Heating of the various sections of the extruder by steam, oil and electrical resistors is discussed as well as temperature control by means of drop indicators the design of and functioning of which is specified.

CABLE EXTRUSION CONTROL. By F. E. Planer, London.

Reprint of an article appeared in "The Wire Industry," August 1953, describing two measuring and control instruments for keeping the diameter of plastic-coated cables constant. Avoiding of scrap and over-dimensions which would otherwise cost the manufacturer much money annually, are the advantages of these instruments produced by Addision Electric Co. of London. One instrument is meant for cable thicknesses of 0 to 25 mm in dia. and permits to keep the diameter constant with a tolerance between plus or minus 0,05 and plus or minus 0,025 mm; the second instrument will indicate tolerance variations up to 0,0025 mm.

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MEXICO

MEXICAN RUBBER AND PLASTICS

No. 94, November 1953

Abstracter: John R. Ballard

NEW PLASTICS ARE BEING MANUFACTURED IN MEXICO

Three companies have recently been merged with Celanese Mexicana, S. A. These are: Viscosa Mexicana, S. A., Claracel, S. A., and Celulosa Nacional, S. A. The management plans to start the manufacture of many products which have previously had to be imported, including industrial fibers, cord for automobile tires, cellophane, and other plastic and chemical materials.

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ELECTRICAL MANUFACTURING

Vol. 52, No. 9, Sept. 1953

Abstracter: Gerald Eisner

NEW NONRIGID MATERIALS FOR THE FUNCTIONAL DESIGN OF ELECTRIAL INSULATING SYSTEMS. By Alex E. Javitz

In this article Mr. Javitz has presented a very thorough evaluation of the new materials now being used or contemplated for use in electrical insulating problems. The materials covered are Polyester Film (Mylar),

(please turn to page 37)

Old Timers Night at Philadelphia Traces Growth and Activities of Section

George Koch, Jr.

The November meeting of Philadelphia Chapter of SPE was held at the Franklin Institute. The program was, "Old Timers Night" and the history of the Philadelphia section SPE. Mr. R. V. Beshgetoor of the RCA Victor Division, a charter member of the Philadelphia section, acted as moderator for the evening.

The first "Old Timer" whom Mr. Beshgetoor introduced was Mr. Richard Bishop presently of Foster Grant Co., Leominster, Mass. Dick gave a history of events leading up to the formation of the Philadelphia section SPE.

In 1942, a group of local men became interested in furthering the development of plastics and plastics products. These men, wanting to exchange views and ideas, formed the Philadelphia Plastics Forum in that year of 1942. Meyer Sperber was elected its first president. It met in a central city loft belonging to one of the 'pioneers'. With the advent of the war and the steady growth of the plastics industry, more and more people became interested in this new field.

In January, 1945, the Philadelphia Plastics Forum moved to its present location at the Franklin Institute. April and May of that year found the attendance reaching a new high when between 300 and 350 people were present at the monthly meetings. At that time, the officers of The Plastics Forum heard about the national Society of Plastics Engineers which was forming new sections throughout the country. The present Philadelphia section SPE was given its charter in September of 1945 with 21 charter members.

The new charter provided the SPE could include only those with a technical plastics background from all the original members of the Philadelphia Plastics Forum. Dick Bishop was elected first president of Philadelphia SPE Section.

In eight years, the Philadelphia SPE has grown from 21 to 165 members and is also the fourth largest in the country.

The next "Old Timer" to speak was Mr. Gerald Mains of the National Vulcanized Fibre Corp. Jerry spoke of the development of the laminated phenolic industry in the Philadelphia area which is the largest laminating area in the country. Some of the companies in this area are: Synthane Corporation; Taylor Fibre Corporation; St. Regis Paper Company, Panelyte Division; Continental Diamond Fibre Company; National Vulcanized Fibre Company; and Brandywine Fibre Company.

Mr. Meyer Sperber was the third "Old Timer" to speak. Meyer spoke of the trials and tribulations in the developments of coatings for fabrics, glass cloth, and other materials. He also mentioned the interest of the Armed Forces during the war in the applications of using more plastics in their defense production for new products and substitutes. Meyer was instrumental in getting many of our plastic materials approved by the government and is currently working with the government on new coating applications.

'Old Timer' John Graf of the John C. Graf Company could not be present with us as he is recuperating from an operation. His recollections were read by Mr. Beshgetoor.

John, who started with the Baldwin Southwark Company, has been in the plastics industry for 25 years working mainly in machinery. He recalled that 25 years ago in molding the first phenolic materials two presses were used. One press heated the mold, the other was for cooling. All molds at that time were hand molds and between cycles they were placed on hot plates to retain the heat. The molding cycle then was approximately ten minutes for an average part.

John also worked on the first semi-automatic press, hobbing presses, and in the development of plunger molding.

Other men who commented on the history of the plastics industry were Paul Froelicher of RCA Victor, who told of the early entrance of Stokes and Smith in the plastics field, and Andy Dukert of Penn Plastics, who discussed the role which the American Viscose Corporation played in the development of the rayon industry. Also heard from was Frank Tuppo, a new member to SPE, who with 27 years experience in the industry explained his workings in the laminated phenolic field.

Plastic Pipe Discussed At Baltimore-Washington

Irvin Wolock

Over fifty people attended the December 8 meeting to hear Mr. Philip S. Britton, Vice President of the Carbon Products Corporation, speak on "The Present Status of Plastic Pipe." Mr. Britton discussed the properties of some of the thermoplastics used in piping. These include polyvinylidene chloride, polyethylene, rigid polyvinyl chloride, cellulose acetate butyrate and the modified styrenes. Polyvinylidene chloride, used first for plastic pipe, has limited use. The popularity of polyethylene can be accounted for by its properties—good chemical resistance, resistance to corrosion, flexibility, resistance to scale building, low friction factor, and long life. Some unfortunate applications of polyethylene pipe of insufficient wall thickness in water mains have caused a lot of trouble. There have also been some unfortunate applications of cellulose acetate butyrate pipe. This material is now being used mainly for gas mains. Rigid vinyl chloride pipe is receiving a lot of attention because of its relatively high tensile strength and excellent chemical resistance. It has poor notch sensitivity, however, and fittings are difficult to mold. The modified styrenes are also creating a lot of interest in the plastic pipe field. These materials have good impact strength, heat resistance, rigidity and chemical resistance. Plastic pipe can be joined by threading, solvent-welding, hot-gas welding, and compression couplings.

There are at present two large-scale research programs underway on plastic pipe. One at the University of Michigan is concerned with toxicity studies, and the other at Battelle Memorial Institute involves the study of tests needed to establish the physical properties of plastic pipe.

High Vacuum Metalization Processes Described to Upper Midwest Section

Mr. Gerald C. Waterman, Field Manager of Consolidated Vacuum Corp., Chicago, Illinois, explained the high vacuum metallization process and illustrated it with accompanying slides at the November 16 meeting of the Upper Midwest Section. Of the three basic high vacuum metallization processes, single side or "rear surface" evaporation, metallization of non-rigid films, and "front surface," Mr. Waterman believes the latter process will replace most, if not all, of the processes currently used because of its lower per unit costs, its special surface effects which can be produced cheaply, use of a minimal amount of metal, and use of cheaper base materials such as regrinds.

High vacuum metallization consists of a 3 step process, the first of which is the application of an "undercoat" of lacquer to seal the pores and eliminate irregularities of the surface, thus forming a base for the metal film.

The second step consists of an evaporation - condensation process wherein a metal (commonly aluminum) is brought to its boiling point by an electrically energized filament in a chamber from which sufficient gas has been removed by a combination of a mechanical and oil diffusion pumps. This process permits the vapors to travel in straight lines from the melting point to the object to be coated without collision with other gaseous materials.

The third step is the application of a top coat of clear lacquer to protect the extremely thin metallic film from abrasion and various solvents, and to provide a medium for introducing color effects.

The complete production system is explained by Mr. Waterman as follows: A riser rod with clips to hold the individual pieces to be metallized serves as a work-carrying device throughout all of the operations. The riser rod is dipped in a lacquer bath and dried in an oven. A number of riser rods are then mounted and rotated in a vacuum chamber during the metallization process. After removal from the chamber, the riser rods are dipped into a second lacquer bath.

This production system is so arranged that there is a minimum handling of parts by the operators. An operation, thereby, can be completed in 15 minutes. The number of parts processed per hour depends, of course, on the size of the part.

Tested high vacuum metallization equipment is now commercially available and technology of lacquer application is far enough advanced to assure production of attractive salable plastic products.

Southern California Ladies' Night Hears Synthetic Fibers Appraised

Austin H. Herbst

Our second annual Ladies Night and Social Program was enjoyed by approximately 50 couples. A cocktail hour preceded a steak dinner. Dr. Walter A. Dew, Pacific District Manager, Public Relations Department of Du Pont spoke informally on the subject "Twentieth Century Fibers and Fabrics."

Through centuries of trial and error, man has learned how to adapt certain fibers which occur in nature to meet his needs. However, in this the twentieth century, industrial progress, rapid transportation and speedy communication have developed new demands for fibers which could not be met with any of the natural ones. Thus man was forced to use his imagination—to carry out research—to develop materials of such character and properties that these new needs could be satisfied. Only recently have we witnessed the results of this new search, the development of 'miracle fabrics' which are designed to fit the specific needs of our times.

Dr. Dew presented briefly the historical background of the development of synthetic fibers and discussed in turn the two types of rayon, nylon polyamid fiber, "Orlon" acrylonitrile fiber, and "Dacron" polyester fiber. The research that led to the discovery of nylon, the first true synthetic fiber, was considered in some detail.

The properties of these five fibers were discussed and the end uses to which they could be adapted was indicated. Comments were made about the practical aspects of clothing containing synthetic fibers in respect to cleaning, care and wearing characteristics.

Mention was made of the importance of such materials in our economy and the possible growth in demand in the coming years. These new fibers are meeting the needs of twentieth century life. A vast new source of important materials has been discovered and man will use it without giving up that which is good but will use it, too. Thus we will witness an increase in our standard of living as a result of these new discoveries.

A set of polyethylene mixing bowls was given to each lady present. The candidates for our coming election for the Board of Directors were introduced from the floor.

TV Show Sponsored By West New England Helps Educate Public

C. W. Petersen

Look to Western New England for the better mousetrap of tomorrow. And don't be surprised if its made of plastic. If inventors in that area take seriously a recent telecast over station WHYN-TV (Holyoke, Mass.), that eventuality is not too remote.

In the minds of a generally misinformed public, the Western New England Section of the Society of Plastics Engineers is attempting to engineer a new understanding about plastics. At 8 p.m. on November 12, three of its members began a half-hour stint before the television cameras to give new meaning to the plastics industry's old, but still exciting, story. The announced goal was to get inventors to think in terms of plastics. But underlying that was an earnest desire to educate the general public.

Those who tuned in saw a styrene toy steamroller which "seems to be making up its mind which way to go," apples sacked in a reusable polyethylene bag which "is ideal for storing bread" and an attractive model clad in vinyl rainwear.

Listeners heard reworkable thermoplastics likened to water and ice, and were told why a molded phenolic part resembles a hard cooked egg. The fact that each plastic material has its own uses and limitations was spelled out carefully.

Most of the products shown were novel and well designed. Discussion purposely was kept on an informal, easy-to-grasp basis.

It was a panel-type program with Guy Strout, president of the Springfield (Mass.) Invention Associates firing the questions. Western New England Section SPE members on the panel were: Edmund S. Childs, president; Sherwood L. Young; and George W. Martin, secretary.

Childs is sales manager for polyethylene resins at Monsanto Chemical Company's Plastics Division (Springfield, Mass.). Young is vice president of C. F. Church Company (Monson, Mass.) and general manager of that company's Plastics Division. Martin is general manager of Noma Lites, Inc. (Holyoke).

New York Section Enjoys Xmas Party

Arthur M. Merrill

The New York Section celebrated another year of continued growth at its annual Christmas party on December 16 at the Gotham Hotel. A capacity crowd of 120 members and guests attended the gala affair which included a cocktail hour, dinner, and an excellent entertainment program which was very well received. As in the past, arrangements for the party were handled by Saul Blitz, Tico Plastics, Inc., and outgoing president of the Section. Table favors were distributed through the courtesy of Dow Chemical Co.; Dow Corning Corp.; Ferro Corp.; Monsanto Chemical Co.; and Rotuba Extruders, Inc.

In a brief business session following the dinner, Mr. Blitz thanked his fellow officers, committee chairmen, and members for their work during the past year, and announced the newly elected officers and directors for the coming year, as follows: president, Harold H. Schwartz, Empire Brushes, Inc.; vice president, William Lewi, Dusal Tool & Mold Co.; secretary-treasurer, G. Palmer Humphrey, R. C. Molding, Inc.; and directors (for three-year terms), Guy Martinelli, Sylvan Plastics, Inc., Irvin I. Rubin, Robinson Plastics Corp., and Carl W. Virgin, Naugatuck Chemical Division of United States Rubber Co.

Mr. Virgin conducted a drawing for some 45 door prizes.

New members added by the New York Section during the past month were: C. P. Bamberger, president, Claude P. Bamberger, Inc.; D. B. Begley, salesman, Reilly Tar & Chemical Corp.; Professor Raymond Eisenstadt, Lehigh University; R. M. Knight, process dept., National Petro-Chemicals Corp.; and M. L. Parker, engineer.

Job Aptitude Tests For Plastics Workers Sponsored by Erie SPE

The Erie Chapter of the Society of Plastics Engineers announces that an aptitude test is available for the job of Injection Molding Machine Tender. Complete job analyses for the job were recently completed by a representative of the Erie office of the Pennsylvania State Employment Service. Studies were made of the job at Quinn-Berry Corp. and Perry Plastics, Inc., both of Erie as a result of conferences with Messrs. James Quinn and J. C. Stokes, presidents, respectively, of these organizations.

Following studies of this job, copies of the analyses were sent to the Central office of the Pennsylvania State Employment Service. This office, in turn, furnished the Erie employment office with an aptitude test battery to be used in selecting inexperienced workers for this job. The test battery measures manual dexterity, finger dexterity and form perception. These were the aptitudes found to be important to this job.

Arrangements are under way to have all plastic industries in Erie screen all new workers for this job through the Pennsylvania State Employment Service where the test is administered and used in selection. This service is free. It is suggested that plastic companies get in touch with the nearest office of their own state employment service for further information on this matter.

Eastern New England Topics "Plastics and You" And Beryllium Copper

Frank C. Dooley

December 3, 1953, the Hotel Beaconsfield was the scene of the combined meeting of the Providence-Boston Chapter of the SPI and the Eastern New England Section of the SPE, Inc. There were two feature speakers for the evening.

Mr. A. A. Belmonte who is the Credit Manager of the Carbide and Chemicals Co., and The Bakelite Co., New York City, New York. Mr. Belmonte is a recognized authority in the credit field and spoke on "Some Current Aspects of the Plastic Industry —and YOU." His talk was extremely interesting, informative, and well appreciated by the large gathering.

Mr. Amelio J. Cocci who is the manager of the Stan-Cast Division of Standard Tool Co., Leominster, Mass., was the second speaker. Mr. Cocci spoke on the subject of "Beryllium Copper Molds Today." As he has been engaged in experimental work developing a centrifugal casting process for plastics, his talk was most instructive and commanded a great deal of interest.

This meeting closed the 1953 season for the Eastern New England section of the SPE. It was a very excellent year and all meetings were well attended and very well planned.

Acrylic Sheet Forming Is B-W Section Topic

Irvin Wolock

W. W. Farr, Chief Service Engineer of the Rohm and Haas Company spoke on "Acrylic Sheet Plastic Fabrication — Latest Techniques and Materials" at the November 10 meeting, held at the Langley Park Hot Shoppe in Washington. Mr. Farr discussed the properties of Plexiglas I-A, Plexiglas II-UVA, Plexiglas 55 and Polymer K, all cast transparent plastics. Plexiglas I-A is the oldest material of the group and has the lowest heat resistance and lowest crazing resistance. Plexiglas II-UVA has higher heat resistance and less crazing sensitivity and is more difficult to cement. Plexiglas 55, originally produced as an "interim" material, has the same forming properties as Plexiglas II-UVA but has better craze resistance and is a little more difficult to cement. It has given excellent results when used in laminated form for windows in commercial aircraft. The newest material, Polymer K, has still higher heat resistance. Its notch sensitivity, however, makes its use in monolithic form questionable for pressurized aircraft. For this purpose, the laminated form is desirable. Suggested forming conditions for these materials were presented.

Glass Fiber Use Told Northern Indiana

James D. Martin

The Northern Indiana group met at Ft. Wayne in the Chamber of Commerce Bldg. on Sept. 18th to hear Dr. R. G. Nelb, of Naugatuck Chemical Co. present an interesting talk on Reinforced Plastics.

Dr. Nelb discussed the production techniques of glass fibre reinforced plastics and the many problems that have been overcome.

The group decided in the business session to try another night than Friday to see if interested parties could more easily attend the meeting.

The Oct. 12th meeting held on Monday evening at the Ft. Wayne Chamber of Commerce was attended by several men new to the group.

Mr. T. D. Maimer of the Bakelite Company spoke on Plastisol Molding and gave a demonstration of the actual compounding of a plastisol as he spoke. The fusing and baking of a prepared plastisol mixture was carried thru to its final and usable state.

Each meeting is proceeded by an informal dinner at 6:00 p.m. at Marchios' Grill. No reservations necessary.

"Our World of Color" Presented at Toledo; Purdue Describes Workings of Patent Law

John C. Purdue

Mr. Creston Doner of the Libbey-Owens-Ford Glass Company was the featured speaker at the annual Ladies Night meeting of the Toledo Section. Mr. Doner's talk entitled "Our World of Color" followed dinner and the awarding of door prizes. It is rumored that every guest (lady), by strange coincidence, received a prize.

In addition to discussing the use of color in decorating, Mr. Doner pointed out a fact which should be of considerable interest to the plastic's industry generally. For a considerable period of time basic trends in the use of color have been on a cyclic basis, each cycle covering a period of about 10 years. As a consequence, it is possible to predict what colors will enjoy most popularity from a knowledge of past trends in that direction.

During the course of the November meeting the problem of membership in the Toledo Section was discussed. Several members of the Toledo Section have been transferred to other areas with the result that membership of the Section has remained constant over the past year. The opinion was expressed that a shift in emphasis generally toward the field of reinforced resins is occuring in the Toledo area, and that some relatively significant members of the Toledo Plastics Industry are not at present represented in the membership of the Section.

Attendance at Section meetings was also considered as a problem warranting relatively serious attention. It has been observed over the past months that attendance at Section meetings appears to vary with the topic being discussed. It has been noted that relatively few topics attract the entire membership, and that the total attendance at any given meeting is likely to be made up of a particular segment of the members interested especially in the topic being discussed. Only a symposium on reinforced plastics held several months ago seems to have been of interest to the membership generally. No solution to the problem of finding topics of general interest to the entire membership was offered; the Toledo Chapter would like to invite the comment of other chapters on the subject of programs.

A movie showing the production and some uses of coated fabrics and unsupported films by Textileather Company was shown. The production of both pyroxylin and vinyl coatings was illustrated, as well as some of the techniques utilized for achieving special effects. During the course of a question and answer period some problems of trade acceptance were discussed. For example, it was pointed out that a particular material produced by Textileather had been tested and found to be eminently suited for use as an inner liner in shoes. However, at the retail level consumer resistance was encountered, apparently because of the belief that the inner liner was a substitute material. The possibility of overcoming this sort of resistance, which is a problem in many plastics applications, by intensive education of salesmen at the retail level was proposed.

Following the movie and question and answer period John C. Purdue addressed the meeting on "Fundamentals of Patent Law." The talk was divided into a brief definition of "patent" generally, a relatively short history of patents in the world, and specifically in the United States, a discussion of what is patentable and statutory bars that will prevent a granting of a valid patent, a discussion of the procedure for obtaining a patent, and a consideration of the nature of a patent right granted by the U. S. Government. Trade-Marks, copyrights, design patents, plant patents, and foreign patents were distinguished from the ordinary mechanical patent with which most people are more familiar. Following a question and answer period on patent law the meeting was adjourned, and a buffet luncheon was served.

Panel Program at Western New England

C. W. Petersen

The Western New England Section's November 4th dinner meeting was held at Bradley Field, Windsor Locks, Connecticut.

The scheduled speaker was unable to make the meeting. The Program Committee did an excellent quick change.

A panel discussion on the subject of material application was substituted. Mr. Bill Bently, Program Chairman, outlined the subject and then turned the meeting over to Sherwood Young as Moderator. The speakers used examples currently being run at their plants to indicate how the right material for a job was determined.

Wes Larsen of DeBell and Richardson, Bill Bentley of Colts, Herb Hagenthal, Lewis Gustafson of Prolon, Jules Pinsky of Plax, and Allan Midyette, of C. F. Church made up the panel. The range of material both in the thermo-plastic and thermo-setting types were well covered by the speakers. This program was one of the most interesting this year.

Milwaukee Group Selects Committee

Marvin C. Stowe

The first meeting of the newly formed Milwaukee Section was held on December 3, 1953 at which time a temporary committee was elected as follows:

Chairman, George Stein; vice chairman, T. M. Mathews; secretary, Frank Bailey; treasurer, John Verburg; new member chairman, Eugene Slingluff; news reporter, Marvin C. Stowe.

A fine dinner was enjoyed by 19 men present at the meeting. All were very much in favor of the new Milwaukee chapter and most of them had several others in mind that would be very interested in joining the Society of Plastics Engineers.

AROUND THE WORLD

(continued from page 33)

Glass-Fiber Paper, Quartz-Fiber Paper, Silicate-Fiber Paper and Asbestos Paper.

In addition to the discussions of each of the above, the article covers experimental work now being performed on insulating tapes made of Saran, Epoxy Resins, Polystyrene, Acetates, Nylon and Bentonite. Excellent charts and tables clearly point out the important differences between the various insulation materials discussed.

THE TREND OF COMPLETE AIRCRAFT AND GUIDED-MISSILE STRUCTURES TOWARD REINFORCED PLASTICS — by William Braham

The author, Chief Engineer of Zenith Plastics Company, describes the problem of selecting materials for aircraft and guided-missiles which are operating at speeds greater than Mach 1.0. Under these conditions surface temperatures in excess of several hundred degrees Fahrenheit are reached with resulting detrimental effects on metals and plastics.

Mr. Braham compares titanium, aluminum, phenolic impregnated glass fibre, stainles steel and magnesium for structural properties at elevated temperatures.

He concludes with a very optomistic forecast of the future utilization of reinforced plastic for the structural components of high-speed aircraft and guided-missiles.

Classified Ads

Engineering Positions Open

CHIEF ENGINEER Large plastic toy manufacturer, metropolitan New York has excellent opportunity for engineer thoroughly familiar with engineering design and production of plastic items from design stage to final assembly. Engineering degree required. Send complete resume. Reply to Box 1054, SPE JOURNAL, 513 Security Bank Building, Athens, Ohio.

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Princeton Offers Graduate Plastics Program

Princeton University is offering a graduate plastics fellowship program, leading to the M.S. degree in engineering. Instruction covers properties, evaluation, production, fabrication, design and application of materials, as well as chemistry of plastics. Program includes lecture and laboratory classes, and contact with industrial plants.

Fellowships with stipends of from $1500 to $2100 plus tuition and fees are available. Opportunities for employment as half-time research assistants at $1500 per academic year are also available to students not on fellowships. Address: Louis F. Rahm, Director, Plastics Laboratory, 30 Charlton St., Princeton, N. J.

"GLORY OF RESEARCH"

Elongation at break is about a million percent—but I'm afraid the tensile strength is a little low.

Liquid Polymers—Epoxies

(continued from page 29)

sulfide liquid polymers should be advantageous in fiberglas laminate structures. The possibilities seen in 100% solids air drying paints are far reaching. However, this latter program is still in the initial stages of laboratory development.

The authors wish to thank members of the technical staff of the technical service and research departments of Thiokol Chemical Corporation for assistance in supplying data and advice in preparation of this paper.

For the convenience of anyone interested in using these products, there follows a list of the commercially available products mentioned in this paper along with their sources of supply:

Product	Supplier
"Thiokol" LP-3	Thiokol Chemical Corporation 780 N. Clinton Avenue Trenton 7, New Jersey
Araldite CN-503 CN-504 E-108 KD-133	Ciba Products Company Kimberton, Pennsylvania
Bakelite BR-18794 Triethylene Tetramine	Bakelite Co., Division Union Carbide & Carbon Corp. 30 E. 42nd Street New York, New York
Epon 828	Shell Chemical Company 500 5th Avenue New York, New York
DMP-30	Rohm & Haas Company Washington Square Philadelphia, Pennsylvania
Burgess Pigment #20	Burgess Pigment Company 64 Hamilton Street Patterson, New Jersey

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(1) Brit. Plastics, **20**, 120-2 (1943)
(2) U. S. Pat. 2,500,600
(3) C.A. **44**, 1170-71 (1950)
(4) Unpublished data, Thiokol Chemical Corporation

Book Reviews

(continued from page 6)

wear. The latter is a particularly thorough exposition of this subject which, though expanding has not been previously described in such detail.

Finally, the problems of selling plastics to the public are described in a series of papers on p.v.c., tableware, toys and design.

The text, while based on the papers given at the British Plastics Convention, allows for very much fuller treatment of the subjects than was possible in the limited time available to the lecturers on the platform. Many of the authors have taken the opportunity to expand their theses more fully, and the book therefore forms a valuable, detailed and authoritative contribution to current plastics technology.

Arcing Tests on Plastics—

(continued from page 15)

Figure 7. Glass-Bonded Mica Sample After Four Arcs.

Limiter blocks molded of this material by another manufacturer survived 6 arcs before carbonization occurred. The 6th arc caused intermittent arcing for about 1 minute. Arcing stopped when one power lead burned clear.

A limiter block molded of mineral-filled melamine by another vendor did not fare as well. Two faults were cleared satisfactorily and the third one caused failure. A second sample of this block was tested with the same results.

Although mineral-filled melamine will carbonize after repeated power arcs, it is considered satisfactory for application as electrical insulation except in such limited applications as arcing chambers, where the material is repeatedly exposed to arcs.

For applications where carbonization of the material can result only from failure of equipment, this material should give adequate performance.

Teflon

Polytetrafluoroethylene, commonly known as "Teflon," survived seven arcs with no sign of carbon tracking. Its ASTM arc resistance is over 200 seconds. Starting with the first arc there were signs of decomposition near the terminals, forming a non-conductive black substance that looked like pitch. However, maximum alternator voltage (550 volts) was applied after each arc and there were no signs of carbon tracking. The area in actual contact with the arc was unchanged after the tests. Because of the nature of a Teflon surface, the molten copper did not wet the surface, but rolled off in small balls.

Within the limits of its molding problems and its mechanical characteristics, Teflon would appear to have distinct advantages as insulating material under arcing conditions. Nevertheless, consideration must be given to the effects of toxic and corrosive gases emitted during the decomposition.

Glass-Bonded Mica

Glass-bonded mica, being inorganic, will not form a carbon track. In fact it gives some rather surprising results. It was very difficult to get an arc started in tests with one alternator—the wires would fuse without starting an arc. The reason for this is not known; it was as though the material emitted some kind of an arc-quenching gas.

(please turn to page 42)

Plastics Scrap

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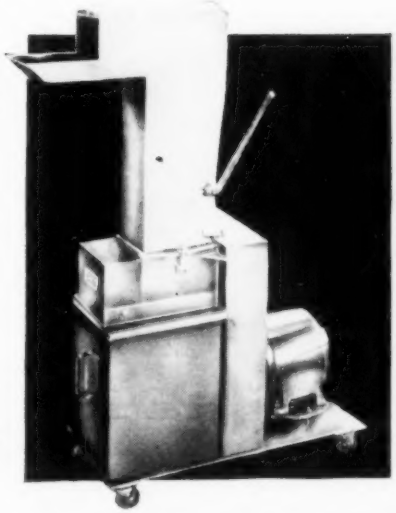

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Election Results at Connecticut Are Announced

David Mersey

December 11 marked the last meeting for the present officers of the Connecticut Section. The new National Director is John Burger. The new Directors are Andrew Wargo; Carl Svenson; Ted Erickson. These directors elected the new officers. John Burger, president; Charles Sullivan, vice-president; James Wheeler, secretary; Paul Foytho, treasurer.

The technical portion of the meeting was covered by Carmen Giannotta of The M. W. Kellogg Co., who talked on Kel-F or polychlorofluoroethylene. He was assited at the projector by Frank Smith of HPM.

Although Kel-F comes in other forms, such as oil and dispersions, we were primarily concerned with it as molding compound. It may be extruded, or molded as compression, transfer, injection.

Newark Elect Officers; Bonanno Is President, Willert, Biklen Chosen

Don Biklen

On Dec. 9, 1953, the Newark Chapter held their annual Christmas Party. It was a gala affair with 150 persons including members and their wives, and other guests. A large dazzling Christmas tree adorned the edge of the ball room floor. Dinner dance music and entertainment was provided by the Marty Ames orchestra.

Table favors were donated by the Dow Chemical Co. The Newark Section had the pleasure of having the Executive Secretary, J. Underwood, as their guest. Many prizes donated by the members and friends were distributed among the group. Everyone had at least one prize to take home. Milt Sanders was chairman of the occasion.

Newly elected officers of the Newark Section: president, Joe Bonanno; vice president, W. Willert; secretary-treasurer, Don Biklen.

Chicago Joint Meet Celebrates Xmas

M. A. Self

The SPE-SPI annual Christmas party of December 5, was attended by over 350 members and guests. Excellent food, entertainment, and fellowship made for a very pleasant evening.

Mr. Austin Kiplinger was the speaker for the January 20, meeting to be held at the Western Society of Engineers, 84 E. Randolph in Chicago. His topic was "What is Ahead" and a question and answer period followed the address.

Yates Extrusion Group Joins N.W. Penn Section

Paul C. Roche

Yates Company, manufacturers of custom plastic extrusions, has recently joined SPE. The Company began operations 18 months ago in its plant at 2211 Peninsula Drive, Erie, Pa. and since that time has doubled its capacity, serving various industries such as chemical, building and furniture. Extrusions of all sizes are offered in vinyls, acetates, butyrates, acrylics and styrenes, with emphasis placed on dimensional accuracy and high speed cutting and packaging equipment. Prompt service offered by this extruder is enhanced by company owned facilities for dies, tooling and engineering development.

The cement block building and all production equipment are new, including three extruders of advanced design, capable of processing [illegible] pounds per month. Personnel is headed by R. N. Yates, owner, James [illegible] Elbin, superintendent, and W. N. Mackie, sales engineer.

The Northwestern Pennsylvania Section is particularly pleased to welcome this firm, diversifying the interest of its members.

Western New England Elects Officers for The Coming Year

C. W. Petersen

The annual Christmas dance attended by 140 of the membership and their wives highlighted the December dinner meeting of the Western New England Section of SPE. A cocktail party and steak dinner preceded the dance and included dinner announcements of next year's slate of officers and directors.

Elected directors to the nine-man board were Ray Mazur of American Cyanamid Company, Walter G. Clark of Parker Stamp Works and Albert Shuanaman of C. F. Church Company. Mazur succeeds himself while Clark and Shunman replace Victor E. Eisenland of Springfield Molders and Paul M. Holmberg of Arrow, Hart and Hegeman, each of whom has served for the past three years.

New officers are: President, George Martin, Noma Lites, Inc.; Vice-President, C. William Bentley, Colts Manufacturing Company; Treasurer, Louis Gustafson, Prophylactic Brush Co. and Secretary, Ray Mazur, Richard Plichta, Fuller Brush Company, was appointed Chairman of the local section's SPE prize paper committee, and C. Paul Fortner of Plax Corporation was named Chairman of the monthly exhibit committee.

An interesting after-dinner talk by Dr. E. I. Stearns of Calco Chemical Division of American Cyanamid Company was entitled "Color Facts and Fantasies."

Dinner music was provided by Ted Albright, and Bob Anderson and his orchestra played during the dance.

A door gift and prizes for contests held during the dance were donated by idividual members. In addition, all the ladies present drew for a wide selection of useful gifts.

Rochester Plant Visit

A plant visitation conducted by Gerard V. Delaire through Eastman Kodak Company's Camera Works Plastic Laboratory and Injection Molding area. After the tour, we met at the Powers Hotel for dinner. Later a question and answer period was conducted.

Can you develop a plastic that is REALLY heat resistant?

Extrusion in Europe

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...processing conditions, and during the run it was found possible to produce sheeting from 30 mils down to 6-8 mils. Figure 12 is a close up of the end of the die with the end plate removed showing details of the spreader bar.

There has been a noticeable increase in the use of the rather thicker variety of flat sheet, not only in the rigid P.V.C.s, but also in the latest types of high impact styrenes, which material has particularly attractive properties for use in the manufacture of refrigerators, radio equipment and many other domestic and industrial appliances.

This sheeting, which can be produced by extrusion, forms the basic raw material for use in the newer process of vacuum forming and other types of press forming, and many manufacturers of machines and equipment, as well as actual extruders, are actively turning their attention towards the production of this large volume product.

Rigid Sheet Made From Tubes

Most rigid sheet that has in the past been produced by an extrusion method in such materials as hard and unplasticized P.V.C.s, acrylics and polystyrene, have been made from a circular die, slitting the extruded tube as it emerges and gradually flattening the tube into the form of a sheet by flattening rolls and the application of radiant heat. This method of production was noted to be in use very satisfactorily in a number of works on the Continent, and examples of rigid P.V.C. sheeting varying in thickness from 30 mils-100 mils and up to 50" wide were noted.

It is felt, however, that the production of flat sheeting by extrusion will be greatly assisted both from a viewpoint of output in pounds per hour, and also quality of the finished product, with the introduction of a satisfactory type of flat die.

Many types of flat sheet dies have been observed in operation, but those which follow the conventional fan tail formation from the extruder mouth to the die orifice inherit the disadvantages arising out of a difficulty to maintain a uniform temperature which could lead to local stagnation in the plastic stream, the difficulty of providing adequate clamps or bolts to keep the two halves of the die together and avoid leaks, and, arising out of that, further difficulty in dismantling the die easily due mainly to the provision of far too many bolts which have been provided in order to take care of the former problem.

A new type of patented sheet die has recently been developed, and a die of this construction was noted in operation under test conditions through a wide range of materials comprising cellulose acetate, polystyrene, polyethylene and soft and hard P.V.C. It is thought that details of the die will be of interest, and a photograph of one of the smaller sizes of this type of die which has been manufactured is shown in figure 13.

The principle features which are claimed for this die are firstly that the plasticized material emerging from the extruder is first directed through two highly polished semi-circular channels devoid of all restriction to the extremities of the width it is desired to extrude. The possibility of stagnation arising out of such an arrangement is claimed to be non-existent, and it is further claimed that the material will extrude from the die orifice more easily at the edges than in the center, which is a reversal of the conditions pertaining to the conventional fan tail design. The two plastic streams are reconnected by a horizontal channel of the same shape before the die faces are opened out towards the orifice. The length of land, and the adjustment consisting of one loose die lip and the usual adjustment screws follow the conventional pattern. A further great advantage claimed in the design of this die is that the center island of metal on each half of the die, and around which the plastic flows, provide possibilities for bolting the two halves of the die together in an extremely strong and efficient manner, and it follows also that the projected area of the plastic stream is very much less than must be the case if a fan-tail configuration is employed. The heating arrangements can be varied to choice using either internal cartridge heaters or the more normal flat plate heaters, but it is also known that dies of this design have been constructed for use with both oil and steam heating arrangements.

Figure 13. Flat type sheet die.

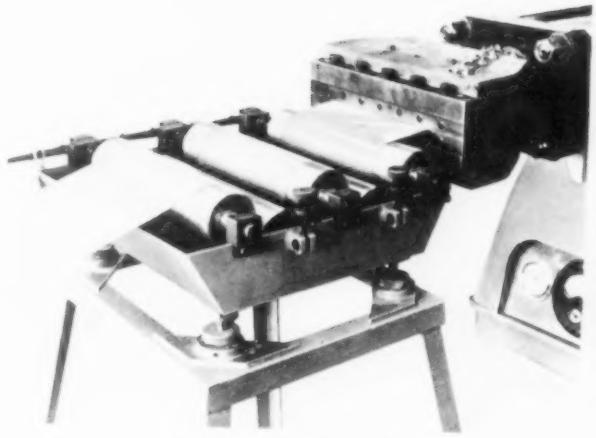

Figure 14. Small flattening rolls.

Take-Off Equipment Is Important

The take-off equipment which is normally in use in connection with flat sheet dies is noted to vary from place to place, but, generally speaking, when extruding the more

Arcing Tests

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We finally wired the center bar only, thereby concentrating the output of the alternator. Even so, it was necessary to raise the voltage to the alternator ceiling of about 330 to 350 volts in order to get an arc started. Once started, the copper apparently supplied enough ions to cause the other two bars to fire, so that all three would fuse.

This material was subjected to eight tests at ceiling voltage. After each test, a little of the material had disappeared. Figure 7 shows the appearance of the material after the sixth test. Here we see the rough surface, apparently consisting mostly of glass. We see balls of copper which, while molten, ran around on the surface like mercury on a table top. We see that glass has tended to form around the balls of copper, isolating them. After eight tests, the resistance of this material had apparently not been substantially reduced.

The glass-bonded mica, having survived the single-alternator tests, with fault currents of 800 amperes, was then subjected to arcs with four 60-kva alternators, in which the fault currents were about 3200 amperes. After four such arcs, the sample looked very much like the sample of figure 7.

CONCLUSION

In conclusion, we have here a very serious problem—and one that will become more serious as airplane electric systems increase in power capacity. All phenolic materials must be designed out of hazardous applications on aircraft, but that will take a great deal of development. It is not just a matter of making direct substitution of some wonder material for the phenolic. Each material has its own peculiar characteristics such as toxicity, dimensional stability, brittleness, and the like, which must be taken into consideration in the overall design.

It is not the purpose of this paper to consider any characteristic except resistance to power arcs. To do so in the proper manner would make the paper too lengthy and divert attention from this immediate problem. To do so on a partial basis would be grossly unfair. The proper solution will not be the same for every application.

In this report we are considering characteristics of basic types of materials. Nothing in this report should be construed as a criticism of any vendor's product. For this reason, we have avoided mentioning any vendor by name.

Nor should it be concluded that airplanes have suddenly become death traps. The history of aviation has always been one of steadily improving safety. Improvement of electrical insulating materials is one of the important and necessary steps in this continuing progress.

REFERENCES

(1) **Arcing Tests On Plastics,** Boeing Airplane Company, Seattle, Wash., film #405.

(2) **Plastics Properties Chart**—1953, Plastics Catalogue Corp., 575 Madison Avenue, New York.

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flexible materials such as cellulose acetate, polyethylene and plasticised P.V.C. of the harder grades, a bank of flattening rolls with internal water cooling arrangements is employed and positioned as near as possible to the die orifice. A small set of flattening rolls is shown in figure 14, actually in use with the before mentioned die. The extruded sheet is being pulled through these rolls by the usual nip roller set-up, followed, of course, by some type of winding gear. In the case of completely rigid materials and polystyrene, the extruded sheet is taken away via smaller closely positioned rolls or cooling tubes, there being no possibility of threading the sheet under and over the cooling rolls as is shown in this photograph.

It has been the intention to present this survey of developments within the industry in Europe mainly from a practical and engineering viewpoint.

It is felt that reference should be made to the [illegible] valuable assistance rendered to the industry as a whole by the technical press on both sides of the Atlantic, and also to the many informative bulletins published by most of the leading plastics material manufacturers giving extremely useful data on up-to-date research made under their direction. This information is being closely studied by all progressive concerns and must be considered to be one of the greatest factors in development.

In conclusion the author wishes to record his thanks to the many concerns who have assisted him in the compilation of the details presented in this paper, and to extend his grateful thanks to the Society of Plastics Engineers in permitting him the opportunity of attending and speaking at their tenth Annual Conference.

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Dear Friends:

As I write to you this month, I'm looking forward to seeing many of you at the Technical Conference in Toronto. There is no better place in the world to find out how little one actually knows about this plastics business. I had a nice visit with the Newark Chapter on Jan. 13 and gave them some of my ideas on "Mold Design—Profit or Loss." The Northern Indiana Section heard about it and asked me to reveal some secrets at home on Jan. 22. Well, thanks for letting me come in and I will see you all in Toronto.

Wayne I. Pribble

Wayne Pribble